

BANANA BOARD RESEARCH DEPARTMENT

JAMAICA

ANNUAL REPORT

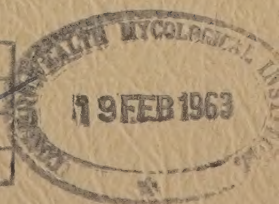
1961



10 SOUTH AVENUE, KINGSTON GARDENS
KINGSTON, JAMAICA.

December, 1962

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BANANA BOARD RESEARCH DEPARTMENT

"Fontabelle",
10 South Avenue,
Kingston Gardens,
Kingston, Jamaica, W.I.
1st December, 1962.

The Chairman,
Banana Board.

Dear Sir,

I have pleasure in submitting the Annual Report of the Research Department for the year 1961.

Yours faithfully,
(Sgd.) EGBERT A. TAI,
Director of Research.

**BANANA BOARD RESEARCH DEPARTMENT
ANNUAL REPORT**

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**1961**



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## INTRODUCTION

In 1961 there was considerable movement of personnel in the Department. The resignation of R. Leach as Director of Research and Plant Pathologist, made necessary a number of changes in the staff organisation and even at year's end there was not a full complement. E. A. Tai, Crop Physiologist, acted as Director from the time of Leach's departure at the end of July, and D. S. Meredith, Assistant Plant Pathologist was appointed to succeed Leach as Plant Pathologist from the beginning of September.

Overseas leave was taken from the beginning of May to mid-July by the Crop Physiologist who attended the Fourth Fertilizer World Congress held at Opatija, Yugoslavia, 9th to 12th May as representative of the Department. The Plant Breeder was on leave, 22nd June to 2nd October, the Analyst from 1st August to 6th November, and the Plant Pathologist from 16th October until after the end of the year, so that for much of the period under review the Department operated at less than full strength of specialist staff.

Among junior staff there were several transfers and replacements to cope with leave and resignations. Districts of 4 Field Officers were changed, an additional Technical Assistant was appointed to work in the Banana Breeding Scheme, 5 Junior Technical Assistants resigned and 3 appointments were made in that cadre.

There was severe drought from the beginning of the year till August in most of the banana growing areas. In the western part of the island, however, the rainfall pattern was favourable for banana growing throughout the year. This was reflected to some degree in the increase over the previous year in the proportion of fruit shipped from Montego Bay and Lucea in comparison with Port Antonio and Bowden as shown in the following table.

| Year | Thousand Stems Banana Shipped from |             |            |              |        |        |
|------|------------------------------------|-------------|------------|--------------|--------|--------|
|      | Lucea                              | Montego Bay | Oracabessa | Port Antonio | Bowden | Total  |
| 1960 | 400                                | 1902        | 2132       | 4514         | 1227   | 10,175 |
| 1961 | 378                                | 1917        | 2705       | 4161         | 1185   | 10,346 |

No appreciable change occurred in the overall acreage of bananas in the island, although there were many new plantings. Most of these replaced areas which were allowed to go out of production because they were becoming uneconomic or were put under fallow in accordance with a plan for control of the burrowing nematode, *Radopholus similis*. In several of the new plantings "cleaned" suckers were employed.

A summary of banana acreages according to figures supplied by the All Island Banana Growers' Association is given below:

| Area         | 1960  | 1961  |         |
|--------------|-------|-------|---------|
|              |       | Total | Cleaned |
| Morant Bay   | 7859  | 8154  | 474     |
| Port Antonio | 4385  | 4681  | 260.3   |
| Highgate     | 27654 | 29410 | 430.3   |
| Montego Bay  | 17967 | 17771 | 39.6    |
| Christiana   | 15608 | 14548 | 43.5    |
| Total        | 73473 | 74564 | 1247.7  |

A notable development in the work of the Department was the taking over at the beginning of the year, through the generosity of the Ministry of Agriculture and Lands, control of a section of the Orange River Agricultural Station to be used for banana experiments. The area of approximately 55 acres was placed initially under the administration of the Agronomist but was subsequently transferred to the control of the executive Field Officer. Direct supervision of operations and performance of the duties of farm manager were made the responsibility of a resident Field Officer.

Acquisition of a 'station' has made it possible to carry out field experiments under complete control by the responsible officers of the Department and so widen the scope of investigations by the specialists.

Banana growers throughout the island continued to give generous assistance to the Department by providing fields of bananas and other facilities for the conduct of experiments; grateful acknowledgment is made here of their valued co-operation and encouragement without which



much of the work reported would not have been possible. The thanks of the Department are also due to members of the staff of the Ministry of Agriculture and Lands, All Island Banana Growers' Association, Sugar Manufacturers' Association and Scientific Research Council for their collaboration on several projects.

## REPORT OF THE CROP PHYSIOLOGIST

E. A. Tai

### Nutrition of the Banana Plant

(i) **Nutritional Disorders:** Extensive chlorosis of Lacatan banana leaves was observed occurring on shallow rendzinas of high soil pH in St. Mary and St. Thomas. Treatment with iron chelate as soil application of FeEDTA adsorbed on vermiculite and spraying with a solution of "Chel DP" (a patent preparation of the iron complex with ethylene diamine di (o-hydroxyphenyl-acetic acid) kindly supplied by the Geigy Company) brought no response although the symptoms associated with the condition appeared to be consistent with those of "lime-induced iron deficiency". Chlorosis of less intensity on leaves of Robusta bananas growing on acid Chan-nerly clay loam gave a variable response to the iron chelate spray; partial greening occurred on a number of treated plants while the controls remained chlorotic. The rate of growth and yield showed no effect.

(ii) **Phosphate Uptake:** The St. Thomas experiment was brought to an end in December after heavy losses in population as a result of two local windstorms in September and November. Very dry weather earlier in the year had severely affected growth and resulted in such variability in the measurements taken that significant differences could not be established between treatments as regards yield or mineral contents of the leaves. The mean values of these were lower than in 1960 as might be expected and confirmed the trend already observed that while nitrogen uptake increased with nitrogen applications it was apparently less when phosphate and magnesium were also applied and that phosphate uptake followed phosphate applications; potassium, calcium and magnesium contents of the leaves did not show any consistent relation with the treatments applied (Appendix Phys. 1).

In April an experiment was initiated in St. Mary on Wait-a-Bit clay, which is acid in reaction and low in nutrients, particularly phosphate, to determine the effects of addition of phosphate in various forms on growth and production. A 5 x 5 Latin Square layout was adopted for the following treatments

- A. 5 oz. Ammonium Sulphate Nitrate fertiliser (26% N)
- B. 5 oz. Ammonium Sulphate Nitrate (26% N) + 6 oz. Dicalcium Phosphate (18% citric soluble  $P_2O_5$ )
- C. 5 oz. Ammonium Sulphate Nitrate + 2.4 oz. Triple Super Phosphate (40% water soluble  $P_2O_5$ )
- D. 12 oz. Granular NPK 10.8.18 (citric soluble  $P_2O_5$ )
- E. 12 oz. Granular NPK 10.5.20 (water soluble  $P_2O_5$ )

with each plot consisting of 9 mats spaced 9 feet by 9 feet completely surrounded by a discard row. The field had been planted in August, 1960, and had received two applications of a 20.0.20 fertilizer before the start of the trial. The first experimental application of fertilizers was done on 24th April and it was then arranged to repeat this at 3-month intervals.

Soil and leaf analyses were done at the start of the experiment and leaf analysis was repeated plot by plot every three months; the samples were collected for the purpose immediately before application of the experimental fertilizer dressings. Despite the effects of dry weather, the experimental plants, with the exception of those receiving only nitrogen applications showed a gain in vigour over others in the same field; they were somewhat later in shooting, and produced bunches of greater average weight. From the laboratory determinations (Appendix Phys. 2) it was deduced that uptake of phosphate apparently affected both growth and yield in contrast to what was observed in other experiments (Tai, 1961). There did not seem to be any appreciable difference between water-soluble phosphate and citric-soluble phosphate in this respect.

(iii) **Nitrogen Uptake:** A field of ratoons at Orange River was selected for testing the effects of different forms of nitrogen fertilizer on Lacatan banana; it had been observed (Tai, 1959) that the nitrate form was more beneficial than ammonium nitrogen for Robusta bananas in St. Thomas. The soil is Highgate Clay and gave the following analysis at the start of the experiment in March.



| Depth       | pH  | ppm                           |                  |
|-------------|-----|-------------------------------|------------------|
|             |     | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O |
| 0- 9 inches | 5.4 | 9                             | 196              |
| 9-18 inches | 5.1 | —                             | 150              |

The layout consists of eight randomised blocks with each plot of eight plants separated by a single discard row from plants of adjoining plots. The fertilizers used are sulphate of ammonia, nitrate of soda, ammonium sulphate nitrate and urea to supply extra nitrogen; basic fertilizer needs are provided by standard 10.5.15NPK dressings four times a year. The applications made to the experimental plants were calculated to ensure equal amounts of nitrogen to each mat.

Measurements made up to the end of the year (Appendix Phys. 3) showed that nitrogen uptake was less in plants receiving sulphate of ammonia than other fertilizer treatments; there were no remarkable differences in the case of other nutrients, however. Vigour of growth and yield were adversely affected by long dry weather during the early half of the year and inadequate control of sigatoka toward the end of the year; no significant differences due to fertilizer treatment were detected.

(iv) **Soil Amendments:** A small observation trial was conducted at Orange River with two soil amendments — Krilium and a proprietary product called "Fertidyne" — on a small area of stiff, acid clay low in potash. Bananas were planted in March with addition of the products to the holes at the time of setting out the suckers and standard cultural practices applied subsequently.

No differences in growth of plants were discernible between treated and control areas at any time during the year.

### Growth of Banana Plants

(i) **Pruning Trials:** The high incidence of toppling as a result of infestation by *Radopholus similis* affected the reliability of sucker counts and made it advisable to discontinue the Portland pruning trial in March after it had been satisfactorily demonstrated that injection of undesired suckers with kerosene or 2,4-D was a practicable method of pruning bananas.

Further testing of kerosene and comparison with other products were undertaken in an experiment laid down in St. Thomas subsequently. A 5 x 5 Latin Square with plots of 12 mats each was demarcated in August in a field planted April. 'Singling' had already been done according to general practice, but 'pruning' proper had not commenced. The suckers were allowed to grow freely until November when the initial experimental treatments were applied to the unwanted suckers.

- A. Control — Standard estate pruning by cutting
- B. Injection with 15 ml. diesel oil
- C. Injection with 15 ml. used crankcase oil
- D. Injection with 15 ml. kerosene
- E. Injection with 15 ml. paraquat.

One week later it was observed that the suckers treated with paraquat and kerosene were either already dead or dying while those treated with diesel oil and used crankcase oil appeared to be only slightly affected. In addition, untreated suckers in mats on which paraquat was used showed bleaching and wilting of the leaves. By mid-December entire mats had died from paraquat treatment but only the suckers directly receiving the other experimental treatments showed any effects. Most of the kerosene-treated had died; the diesel and crankcase oils had caused temporary checks to growth only and some suckers had begun to put out new leaves; the majority of those suckers which had been cut were again growing vigorously.

Dissection of mats killed by paraquat revealed that death followed by rotting had commenced at the growing point of each sucker and progressed outward to the rest of the corm. It was then decided that the systematic activity of this chemical made it unsuitable for use in pruning of bananas by injection. For continuation of the experiment the paraquat-treated plots were replanted and arrangements made to do pruning by cutting the suckers.

(ii) **Observations on "cleaned" suckers:** Germination of pared suckers was appreciably slower than that of unpared suckers and the vigour of subsequent growth also showed a similar difference. Dissection of plants from the different treatments at monthly intervals starting in January showed that 'heart growth' in the case of suckers set upright took place as a



continuation of elongation of the main axis whereas 'side-bud growth' or 'heart growth' from suckers set on the side occurred as new growth with formation of a secondary corm.

It was found that 'heart growth' was not invariably the case in all the suckers planted upright; frequently lateral buds elongated to provide the "germinating" shoot. This was taken as explaining the delay often observed in the starting of growth from plots planted with 'cleaned' suckers as compared with currently standard practice.

(iii) **Chemical killing of banana plants:** Trial of various chemicals for killing banana plants by injection was started in February on a field of old ratoons at Orange River. In the initial experiment exploratory applications were made to groups of 10 mats each as follows:

2,4-D low volatility ester 1% a.e.

diquat 1%

NAA 1% a.e.

2 commercial herbicidal spray oils.

The injections were made with a soil injector calibrated to deliver 5 ml. with each stroke and each plant treated was injected at three points, half the number of a group in the pseudostem near to the base and the other half in the corm below ground level. Suckers under 18 inches tall were not treated; all other shoots in a mat were.

At two weeks after application of the treatments those plants which received diquat in pseudostem or corm were dying; the aerial portions shrivelled and collapsed in four weeks but the corms remained alive and continued to produce unhealthy-looking water suckers. The plants injected in the pseudostem with 2,4-D or NAA broke at ground level within the first two weeks and subsequently recovered; those injected in the corm showed no visible ill effects at any time. The herbicidal oils produced only local injury on the larger plants but killed some of the smaller suckers in four weeks.

Recovery took place by the end of April in nearly all mats other than those treated with diquat; in no instance was there complete kill. Further testing of chemicals for killing banana plants in the field was then handed over to the Agronomist.

### **Fruit Investigations**

(i) **Crop Timing:** Observations were continued on the plants of the Gibberellin experiment at Orange River until the last fruit produced had been reaped. The results were extremely variable (Appendix Phys. 4) and showed that effects of the GA treatments were adverse on growth of plants, flowering and fruit development, although the drought during the early months of the year contributed to the overall poor performance.

(ii) **Shrinkage of fruit in storage and transport:** The loss in weight of fruit during shipment from Jamaica to United Kingdom was determined over three consignments in "summer" and three in "winter". In each instance 50 stems selected for uniformity of grade were carefully weighed and tagged on the wharf prior to stowing in the ship's hold and arrangements made to have them weighed on arrival at U.K. port. It was found that mean losses were 5.5% in summer and 4.5% in winter with a slightly higher rate of loss in the heavier bunches. A detailed report on the project was prepared and submitted separately.

(iii) **Latex staining:** The inducement of style abscission by means of chemicals was abandoned as an approach to the problem after testing of a large number of "plant hormone" and desiccant sprays and concentration directed to development of a bath to remove stain from the fruit after harvest.

Fresh latex was easily washed from fruit by immersion in water. The ooze from cuts and bruises was not stopped, however, and fruit cleaned in this way did not remain so; furthermore, dried latex was not affected. The addition of oxidising agents to the water proved a way of solving the problem; the dissolved polyphenols present in oozing latex were, presumably, precipitated as phlobaphenes which served to block the sources of the latex ooze and dried latex loosened by combined chemical and physical action was washed away.

Of the chemicals tried the simplest to use were potassium permanganate in acid solution and sodium hypochlorite in alkaline solution. These could be used in relatively high concentrations, up to 1%, for rapid results and injury to the bananas was prevented by rinsing in fresh water after treatment. The permanganate was introduced into the bisulphate bath required for washing Bordeaux-sprayed bananas but a special bath was required where hypochlorite was used; the addition of wetting agent to the rinsing bath proved of advantage. It was



arranged to make experimental shipments of treated bananas to U.K. for observation of the commercial application of the method.

Adoption of wadding-wrapping of fruit for export was effective in elimination of latex staining by absorption of fresh latex as it appeared and protection of the fruit from bruising which might give rise to additional oozing of latex. Trial of various types of wadding and techniques of application was planned for 1962.

(iv) **Boxing of bananas:** Observations were made on experimental shipments of bananas as hands packed in cartons commencing in October. The cartons used at the start held 56 lb. of fruit but at the end of the year another type holding 42 lb. net was adopted.

The outturns reported by the Banana Board's marketing agents in U.K. were excellent in most instances. High incidence of crown rot occurred on occasion, however, in spite of treatment of the cut surfaces with Shirlan WS (a proprietary fungicidal preparation). The latex oozing at the time of processing the fruit was adequately dealt with by cutting under water to which sodium hypochlorite had been added.

### **Photography**

The production of photographs for use of the Department was continued. A high percentage of the black and white work was done by the Technical Assistant in charge of the photographic darkroom whereas colour processing was given to commercial establishments. From the output of the darkroom 487 monochrome prints were used.

## **REPORT OF THE ANALYST**

**Dorothy E. Boland**

### **Laboratory**

Samples received for analysis during the year totalled 957 comprising mainly leaf samples from departmental field experiments and a number of *ad hoc* investigations but including also fertilizer samples; approximately 6,000 determinations were completed. The acquisition of an extra room vacated by the Soil Chemist when his activities were transferred to the new wing of the laboratory helped to alleviate the cramped situation which previously existed in the plant laboratory and made possible arrangements to cope with an increased volume of work.

The oxalate method previously used for the determination of calcium was replaced by a method using EDTA after removal of phosphate interference by potassium metastannate (Ling, 1958). All other analytical methods remained the same.

### **Leaf Analysis**

(i) **NPK Experiment:** In a 3<sup>3</sup> NPK experiment in Trelawny which was sampled in April, leaf nitrogen showed a significant increase with application of increasing amounts of nitrogen, leaf phosphate increased when increasing amounts of phosphate were applied and leaf potash showed a significant decrease in plots receiving the higher level of nitrogen. Leaf calcium showed no significant difference for any treatment but magnesium decreased significantly in plots receiving only nitrogen or phosphate (Appendix Anal. 1).

Although the area is known to be generally low in phosphate a response to phosphate applied as single superphosphate was not detected in the previous statistical analysis of results of leaf samples collected in November, 1960 (Boland, 1960). There was absence of the significant differences previously observed between blocks of the experiment and between plots receiving potash application as regards potash contents of leaves.

(ii) **Banana Soil Fertility Survey:** In June, leaf samples were collected from 33 banana-growing properties scattered throughout the island. (Appendix Anal. 2). There were three plots of 100 plants on each site which had previously been used to test the effect of the nematocide applications and it was planned to take advantage of carefully recorded yields over two crops to correlate, if possible, productivity with nutrient status.

Nitrogen (%N) results varied from 3.52-2.35; Phosphate (%P<sub>2</sub>O<sub>5</sub>) from 0.75-0.43; Potash (%K<sub>2</sub>O) from 4.68-2.69; Calcium (%CaO) from 1.39-0.58; and Magnesium (%MgO) from 0.58-0.31. Analysis of variance done on the leaf analysis results for each nutrient, showed significant differences between sites, but not between treatments. The results of the leaf analyses have therefore been taken as giving a picture of nutrient status at the various sites.

Several of the calcium and magnesium values were below the tentative levels of adequacy proposed in 1960. It was discovered that a highly significant correlation existed between leaf calcium and soil pH; leaf calcium values increasing with rise in pH of the soil. It was also noted that where leaf calcium was high, there was a tendency for magnesium to be low.

A full report on the project which was undertaken in collaboration with the Soil Chemist, Agronomist and Executive Field Officer is to be published elsewhere.

### **Refinements to Leaf Sampling Technique.**

Two projects were initiated. In one of these the object is to determine the optimum number of samples required from any given acreage to give a true picture of the nutrient status of the area; arrangements were made to commence the sampling in 1962. The purpose of the other project is a study of the effect of time of year on mineral composition of banana leaves.

The work of other officers of this department has given indications of increased growth rates in banana plants, increased weight of marketable fruit and increased uptake of nutrients between March and July. To determine the extent of this seasonal variation leaf samples were taken from each plot of the NPK fertilizer trial in Trelawny each month between April and November for analysis and arrangements made for continuing the monthly collection of leaf samples throughout 1962.

### **Mineral Content of Banana Plant.**

Two healthy banana plants with fruit approximately 6 weeks old were dug from the Bodles nematode-free nursery in St. Catherine. They were divided into roots, 'corm', pseudo-stem, fruit, fruit stalk, inflorescence, bract, short leaf, lamina, midribs, petioles, dry leaves, and after each part was weighed a representative sample was taken for analysis. The results of determination are given in the Appendix (Anal. 3).

The total weight of potash in mature plants was about 4 times as high as the weight of nitrogen. All the plant parts were rich in percentage potash with the exception of the dry leaves. The fruit stalk, fruit, short leaf, inflorescence and the lamina were relatively high in percentage phosphate content. The lamina and inflorescence contained the highest percentage of nitrogen.

The soil at the site is slightly alkaline in reaction, high in available phosphate and potash. The area was planted in June 1960 and the plants received  $\frac{1}{4}$  lb. Mixture C (10-5-15) fertilizer every month for six months after planting, and later  $\frac{1}{4}$  lb. Mixture C every 3 months.

## **REPORT OF THE SOIL CHEMIST**

**C. G. Jordine**

### **Laboratory**

During the year 3,956 determinations in duplicate and 254 singly were carried out on soil samples taken in *ad hoc* investigations and also for fertilizer advice upon growers' requests. Preliminary work also began in the investigation of methods for the determination of available manganese in soils.

### **Banana Soil Fertility Survey**

In an island-wide series of injection experiments on different estates to test the effect of Nemagon on the control of nematodes (Leach, 1960), the results showed no beneficial effects of the nemagon injections and the recorded yield data were regarded as the result of soil and climatic conditions on bananas in those areas. It was decided to use the data from these plots in a survey to find out more about soil and ecological factors which favour good banana production. These plots were sited at different elevations, on different soil types all throughout Jamaica on land typical of the majority of properties growing bananas.

The records already taken are yield, rainfall as recorded by the nearest meteorological station, soil type and drainage conditions. Arrangements were made to do determinations as follows:

(1) Soil Analyses including: (a) Mechanical Analysis, (b) Moisture Equivalent Percentage, (c) Available Potash from N/2 Acetic Acid soil extract, (d) Available Phosphate by the Truog method, (e) pH by the Glass Electrode method, (f) Percentage Organic Carbon by the Walkley



and Black Wet oxidation method, (g) Clay mineral analysis with the help of the Scientific Research Council.

(2) **Leaf Analysis:** This involves determinations for the macro elements, Nitrogen (N), Phosphorus ( $P_2O_5$ ), Potassium ( $K_2O$ ), Magnesium ( $MgO$ ), Calcium ( $CaO$ ), and also the minor elements, Manganese, Zinc, Copper, Molybdenum and Boron.

The Analyst, Agronomist and Executive Field Officer are in close collaboration with the Soil Chemist on this project: a full report is to be prepared for publication elsewhere.

### **Micronutrient Trial**

Results of the second ratoon crop (Appendix Chem. 1) show that none of the trace elements produced a positive response in any of the factors measured. It was observed that plants treated with the zinc chelate showed a significant decrease in girth of pseudostem at shooting and in the number of hands per stem. The very high coefficient of variation obtained in the analysis for days to shooting might be partly explained by the effects of drought.

### **Liming Trial**

This experiment was terminated after one year when statistical analysis was carried out on results of the plant crops (Appendix Chem. 2). There was no significant effect on days to shooting, height at shooting nor girth of pseudostem at shooting ascribable to experimental treatment. However, there appeared to be a significant reduction in number of hands per stem with the higher doses of lime. The changes in soil pH resulting from lime applications are given in the appendix to this report.

### **Forking Experiment**

The only significant differences resulting from the various forking treatments with respect to height at shooting, girth of pseudostem at shooting and the number of hands per stem were due to frequencies which did not, however, significantly affect number of days to shooting. (Appendix Chem. 3). The experiment continues.

### **Further observations on Manganese Deficiency of bananas**

The symptoms, cause and soil relationship of manganese deficiency were described in a previous report (Jordine, 1960) and its possible connection with speckle was considered. Investigation during the year was concerned with methods of control, attempts at inducing it and the effects of manganese on speckle.

(i) **Control:** Foliar spray treatments and soil application of chelates are the two lines being explored.

(a) **Foliar spray treatments:** This experiment at Hopewell, St. Mary (Jordine, 1960) where the plants are sprayed on a monthly cycle was continued. Plants sprayed with 1% Manganese Sulphate were free from any leaf symptoms of the deficiency but fruit produced was again slightly affected with the brown to black scab-like spots. (Appendix Chem. 4). It seems that although a monthly spraying treatment of 1% Manganese Sulphate supplies sufficient manganese to eliminate leaf symptoms a higher level of manganese is required in the plant to eliminate the scab-like spots, and this, therefore, suggests a more frequent cycle of spraying.

(b) **Foliar application of manganese in Bordeaux mixture:** An experiment was planned to determine whether applications of 1% Manganese Sulphate incorporated with Bordeaux Mixture for leaf spot control could be used to control manganese deficiency in bananas. An area of affected plants was divided into two sections for each treatment. Eighteen plants were selected from each section and a three-weekly record kept of the degree of affection of the leaves. Three sprayings were carried out and after 7 weeks there was no improvement in leaf condition of plants receiving manganese sulphate. It was assumed that the manganese became inactivated by being converted to the hydroxide and later insoluble oxides; an indication of this was observed when Bordeaux mixture containing the manganese sulphate became coffee-brown in colour.

(c) **Soil application of manganese chelates:** On the rendzina soil known as Kilancholly Clay very little improvement has been observed in affected bananas receiving  $\frac{1}{4}$  lb. of manganese chelate 3 times per year (Appendix Chem. 5).

(ii) **Manganese deficiency inducement:** Manganese deficiency in bananas has been observed on areas of Wait-a-bit Clay made alkaline by lime. An experiment of a Latin Square design was set up to induce the condition in one field on this soil. The treatments consisted of (a) Control (no lime), (b) Liming to  $\frac{1}{2}$  the lime requirement, (c) Liming to full lime requirement, (d) Liming to four times the lime requirement. No symptoms of the deficiency had appeared at the end of the year.

However, in another area previously free from the disorder the induction of the deficiency was observed as a result of limestone thrown in a section of a banana field during construction work on a petrol station.

(iii) **Manganese and Speckle:** Wherever the black scab exists on banana fruit there is usually every gradation in size of spot from the typical speckle to the scabs of varying diameters; both are caused by the same fungus *D. torulosa*, the black scabs being associated with conditions of low manganese in the banana. An experiment in which fruit was sprayed with 1% manganese sulphate solution to determine the effect of manganese on the incidence and degree of speckle was undertaken in collaboration with the Plant Pathologist.

Thirty plants which had just shot were chosen randomly in a field receiving under-tree irrigation. A field with this mode of irrigation was chosen because the plantation atmosphere would be very humid and hence would favour a high incidence of infection by *D. torulosa* (Meredith, 1961). Fifteen of the plants (fruit and leaves) were sprayed with a 1% solution of Manganese Sulphate and the other fifteen with water (both with Triton X-114) twice per week. A visual assessment of the degree of speckling of the fruit was made after 7 weeks using an arbitrary system of ratings as described by Meredith (Meredith, 1961). All fruit were then inoculated by spraying with a suspension of *D. torulosa* and each covered with a polythene bag firmly tied at the open ends to maintain conditions very humid, favourable for infection by the fungus. The polythene covering was removed after 24 hours and an assessment of the degree of speckling carried out 10 days later in order to allow sufficient time for speckle development. One week later two fingers each from the mid section of the top and bottom hands of each fruit were taken, washed thoroughly in the laboratory and analysed for manganese. Whenever the top or bottom hand consisted of less than 8 developed fingers the next nearest hand was used for sampling.

The results of this experiment (Appendix Chem. 6) show that although manganese might have been absorbed by the fruit to produce a significant difference in its content in treated plants as compared with controls yet there was no significant difference in degree of speckling of the fruits, one of the fruits sprayed with water showed up two scab-like spots.

Another experiment having as treatments monthly foliar applications of manganese sulphate, Versenol F (an iron supplying compound) and a combination of manganese sulphate and Versenol F was laid out to further investigate the effect of manganese on speckle and on yield of fruit on the St. Catherine plains.

### **Zinc Deficiency in Lacatan Bananas**

A peculiar chlorosis of Lacatan bananas has been observed on the recent alluvia of St. Catherine plains for a number of years. Preliminary investigations by Tai, Boland and Jordine (1959) showed extremely high phosphate in the soils and the leaves in such areas. It was then suggested that the condition might be a "phosphate toxicity".

The foliar symptoms of the disorder, with the exception of the yellowing, closely match the symptoms of zinc deficiency as described by Moity (Moity, 1954) for the Dwarf Cavendish variety in the French Guinea. This fact along with the response obtained to zinc sulphate and the existence of mottle-leaf (zinc deficiency) in the same area strongly support identification of the condition.

It has been recommended that to affected young plants a 0.5%  $\text{ZnSO}_4$  solution (5 lbs.  $\text{ZnSO}_4$  to 100 gallons of water) plus Triton X-114 be applied to the leaves, repeating this treatment if after two weeks the condition is evident on new leaves.

(i) **Leaf Symptoms:** Symptoms of the disorder are commonly observed in plants 2-5 months old. The foliage usually appears bunched and the growth habit stunted. Affected leaves may be uniformly narrow, or narrower towards the tip end and the petiolar end (or less often the reverse). Length breadth ratios of up to 8.6:1 have been recorded. The colouration of affected leaves vary and may be:

- (a) apparently wholly green;
- (b) green with transverse pale stripes bleached of chlorophyll alternating with transverse greener bands;



- (c) Bleached of the normal green colour thus being creamy white. Leaves may also be almost completely bleached at the petiolar end and greener with transverse chlorotic bands towards the tip end. Colour symptoms appear to be shown up to a greater degree at the petiolar end.

Numerous lighter coloured blemishes, oblong in shape, and parallel to the leaf venation develop in the pale green and bleached areas of the leaves. These blemishes seem like 'dashes' and many of them become necrotic upon ageing. Some of the chlorotic and whitish areas on the affected leaves develop into necrotic spots with concentric rings.

Leaves described as under (b) and (c) soon become yellow on ageing particularly in the pale green areas, and this yellowing is more pronounced on the side which faces the sun than on the shaded side. Leaves described as under (a) may also show a yellowing but there are plants with leaves with no chlorosis nor any noticeable narrowing which show up a yellowing particularly near the mid-rib on the side facing the sun. Affected plants may produce a few normal leaves which may be followed by affected leaves once more. Many of the plants grow out of the condition but it may recur just before or at flowering. Leaves of plants showing signs of the deficiency develop more marked symptoms as the fruit develops. Other plants with indiscernible symptoms may show up a bronzing or yellowing of the leaves as the fruit develops and this bronzing is more marked at the petiolar end of the leaves.

(ii) **Fruit symptoms:** Fruit development on severely affected plants is slow; the young bunch remaining in a horizontal or near horizontal position for an unusually prolonged period. The fingers appear twisted, and are shorter, smaller, thinner and usually lighter green in colour than those of normal fruits. Fingers of fruit of affected plants fail to fill out properly resulting in a nipple-shaped appearance to the distal end, thus the weight of such fruit is considerably reduced. Very severely affected plants may produce an inflorescence on which the fingers completely fail to develop. A high incidence of what is described as gold tip or sun scorch occurs among affected fruit and this may be due to reduced protection caused by the reduced leaf area. The deficiency itself may also be directly concerned.

(iii) **Soils:** Caymanas Sandy Loam and Caymanas Clay Loam are the two soils encountered in the areas. Incidence of the condition is greater on the sandier areas. These soils are alkaline in reaction, usually high in available phosphate and potash, well-drained internally and were originally some of the highest yielding banana soils in the island.

(iv) **Foliar spray treatments and results:** Three each severely affected young plants were chosen for the following treatments: 1% Zinc sulphate, 1% Manganese sulphate, water (control); Triton X-114 being added to all solutions. A monthly record was kept concerning the condition of each leaf. After 3-4 weeks there were some signs of improvement of plants treated with zinc sulphate. Leaves of such plants showed some scorching. Spraying was stopped and resumed one month later when the plants treated had produced greener leaves of normal shape and size whereas other plants showed varying degrees of the disorder.

(v) **Length-breadth ratio and chemical analyses of leaves:** Leaf samples were taken from sixteen affected and sixteen unaffected plants in St. Catherine. Length and breadth measurements of sampled leaves of these plants showed affected plants as having significantly higher length-breadth ratios. Phosphorus, calcium and potassium were found to be significantly higher in affected plants (Appendix Chem. 7). A full report on the investigation has been prepared elsewhere.

## REPORT OF THE AGRONOMIST

V. R. Lumsden

### Fertilizer Experiments

(i) **NPK Trials:** At the beginning of 1961 there were four complete  $3^3$  factorial experiments in progress. Two of these were sited in St. Mary, one in Trelawny and one in St. James. An additional experiment using nematode-free planting material was laid down in St. Thomas.

(a) **St. Mary:** The two experiments were terminated early in 1961 as it was considered that no further information was being received.

(b) **St. James:** This experiment was terminated when the field was thrown up by the property management. Too few records were obtained for an analysis to be carried out.

(c) **Trelawny:** This experiment was continued. More vigorous growth and earlier fruiting were observed in the plots receiving high nitrogen. Inter-block differences were also becoming apparent during the year.

(d) **St. Thomas:** This experiment was laid down on gravelly loam developed from recent alluvium. The plots were planted in April and shooting was well advanced by December especially in the plots receiving high nitrogen.

(ii) **Other Fertilizer Trials:**

(a) **Urea Experiments St. Catherine Plains:** With the object of determining an economic level of fertilizer, using urea, for bananas grown on the plains, two experiments were initiated. The layout was the same in both cases and consisted of a randomized block design with five replications of the following treatments:

- A. 4 ozs. /mat/month
- B. 4 ozs. /mat/2 months
- C. 2 ozs. /mat/month
- D. 2 ozs. /mat/2 months
- E. No fertilizer

In one experiment the population was 901 roots to the acre and in the other 604 roots to the acre. Both were planted in May 1959 and the first experimental treatments applied in August 1959.

The initial growth was good but the appearance of the field deteriorated during the "winter" months of 1959/60. Soil and leaf analyses were carried out but the results showed no difference when compared with other fields in the area. The growth of the plants in this experiment continued to be slow and the quality of the fruit was generally poor. Two crops were reaped up to December 1961. No significant differences between treatments were obtained with respect to total numbers shot/plot, average number of hands/stem/plot, total number of count bunches/plot and average number of weeks to shooting for the plant crop and the ratoon crop. (Appendix Agr. 1). Although the treatment of 4 ozs. urea/mat/month gave better results throughout, the extra expenditure for the cost of the fertilizer and for its application was not justified by the increases over the no-fertilizer plots. The occurrence of zinc deficiency in the area in which this field is situated has been established by the Soil Chemist and it is possible that the continued poor condition of the experiment might be due to this deficiency.

The experiment in the more densely populated field was terminated at the end of 1961 when the estate management decided that the field should be put into sugar cane in 1962.

(b) **Mixture C (10-5-20) Fertilizer Trial — St. Mary:** This experiment was laid down to find an economic level and also the most advantageous method of application of this widely used fertilizer. The layout consists of 3 randomized blocks of 12 plots each. The treatments consist of all combinations of 4 levels of fertilizer and 3 methods of application. The levels of fertilizer consist of 0, 2, 4 and 8 lbs. of mixture C applied in 4 equal dressings per annum. The method of applications consists of broadcast, circling around plant and circling around plant with hoeing of fertilizer into the ground. This experiment was laid down on recently terraced hill lands in St. Mary.

## **Cultivation Experiments**

(i) **Crop Timing Experiment:** Three experiments, designed to regulate the cropping of bananas by pruning, initiated and laid down by the Crop Physiologist, were handed over for continuation. These experiments were terminated during the year. No information of value was obtained from these experiments because of the non-conformity of sucker production at all three sites — St. James, St. Mary and St. Catherine — to the expected pattern.

(a) **St. James:** This was located on hillside lands where it was considered that the time taken from planting to reaping should be 15 months. The field was planted in July 1956 and the first crop was reaped during the "winter" months of 1957/58. The field was taken over in January 1958 and divided into two sections. One section received the standard estate pruning practice while the other section received the experimental "15 month" pruning as recommended in the Banana Board Research Department's Occasional Bulletin No. 1 (Tai, 1958). This method of pruning requires the selection of suckers which develop in February and in June of each year to be left to produce the following year's cropping. Growth in the field was not uniform and at each pruning a large percentage of "insurance" suckers had to be left in the experimentally pruned section to insure the maintenance of the population. The suckers were not produced as expected, so that February and June suckers occurred only occasionally in the same mats. This meant that either a February or a June sucker had to be left and this tended to reduce the production from the experimentally pruned section.



The production of fruit in 1960 and 1961 from both plots was affected by "blowdowns" caused by high winds in December 1959 and October 1960. Troughs and peaks of production from both plots coincided very closely, probably due to the number of "insurance" suckers that had to be left in the experimentally pruned area.

(b) **St. Mary:** This consisted of a simple observation trial laid out as a 3 x 3 Latin Square. The three treatments consisted of standard estate pruning, a 12-month pruning regime and a 15-month pruning regime: The 12 and 15-month regimes were as recommended in the Banana Board Research Department's Occasional Bulletin No. 1 (Tai, 1958). The field selected was low-lying and considered to be in a "12-month" area. A 15-month pruning regime was therefore only included because the bananas were interplanted with coconuts and coconut shade tends to increase the length of the growing period.

The field was planted in May 1957 and the different pruning regimes started in February 1958. Each plot consisted of 18 mats arranged so that no coconut trees fell within the plot.

The initial vigorous growth of the plants was affected by heavy rains in May 1958 followed by periods of drought in August 1958, and in the summer of 1959 and 1960. In January 1960 heavy rains led to the flooding of the field. The local management policy of non-use of inorganic fertilizers perhaps also adversely affected the later growth of the plants.

The results of this trial showed that although the 12-month regime produced more stems in "summer" and fewer stems in the "winter" months than the other two regimes, the differences were not significant. (Appendix Agr. 2).

(c) **St. Catherine Plains:** This was laid down in an area where the plant crop is normally reaped within 12 months from planting. The field selected was planted in April 1957 and was taken over in September 1958. The area was divided into 2 sections, one receiving the 12-month pruning regime as recommended by the Banana Board Research Department's Occasional Bulletin No. 1 (Tai, 1958), and the other section being pruned according to standard estate practice.

Leaf spot control in this field was done by oil-spray except for the period from February 1959 to April 1960. Although this field was irrigated the sucker development and general growth was adversely affected by the dry conditions prevailing during the summer of 1959. The production of 1961 was severely affected by the high winds of December 1960 which destroyed approximately 30% of the field. Further losses were suffered from high winds in February 1961.

Because of these high losses of fruit from blow-downs, jumping out heart, praedial larceny and being eaten by animals which strayed into the field, the data relating to the reaping of fruit bore little relation to the recorded shooting from the plots. Although the estate-pruned section produced more fruit during the period January 1959–December 1961, the peaks of production tended to coincide (Appendix Agr. 3).

(ii) **Weeding and Forking — Portland:** The experiment was terminated when the entire field was weeded and reforked in error by the property management after two ratoon crops. A breakdown in the weight collection system coupled with the losses of fruit from the blow-down in 1960 led to the loss of the weight records for the 2nd ratoon.

From the results it was seen that the forking tended to give better results than non-forking but these increases were not statistically significant. The clean weeded plots gave the best results both in respect of weight/stem and average number of hands/stem. The increases for the weight/stem were not significant. For the average number hands/stem the clean weeded plots were significantly better in the 2nd ratoon than the non-weeded plots but not significantly better than the circle-weeded plots. This might be due to the fact that the weed coverage in Blocks II and III consisted mainly of a variety of grasses which would have the effect of competing heavily with the banana for nutrients. In Block I the weed coverage was mainly water-grass (*Commelina* sp.). Forking or weeding did not appear to affect the marketability or openhandedness of the fruit.

(iii) **Banana Killing Observation — St. Mary:** The object of this observation was to find out whether it was possible to kill bananas quickly and economically by using injections of chemicals to replace the laborious process of digging out in preparation to fallowing for ridding the land of the banana eelworm.

This trial was laid down in an old banana field at the Orange River Station and the chemicals used were Sodium TCA, diuron, dalapon, diquat, 2,4-D (non-volatile ester), PCP, kerosene, 2,4,5-TP and two herbicidal oils.

Injection of 15 c.c. of a liquid preparation of each product was done in 3 different positions by the use of a soil injector — the corm, the pseudostem and the centre of the cut surface of the pseudostem 12" above ground level. Spectacular effects were obtained with 2,4,5-TP and diquat. Within a week the pseudostem of the plants treated with 2,4,5-TP had broken off or were bending over; the following week there was some evidence that translocation had taken place as the suckers showed bending of the pseudostem, leaf-sheath splitting and deformed leaf blades. Rotting was not extensive in the corm and within 3 months healthy new suckers were being produced. The effect of diquat appeared as a severe burning of the leaves of all the injected plants. This burning was seen first on the heart leaf and spread outwards to the older leaves, the petioles, midribs and veins being burnt first and eventually the lamina and leaf margins; affected leaves completely dried up at the end of two weeks but there was no visible effect on the suckers. By the end of three months the aerial portions of the injected plants were dead but the suckers had not been seriously affected.

After two weeks the only effect of the sodium TCA was a slight bronzing of the older leaves. At the end of six weeks withering of these had taken place and the suckers started to show splitting of leaf sheaths, wrinkling of the heart leaf and the production of small chlorotic new leaves. At the end of 3 months the pseudostem-injected plants were dead but in some mats there were still live suckers. The other chemicals all had varying effects, usually, resulting in death of the aerial portions of the pseudostem-injected plants. The corms, however, remained alive and were producing healthy new suckers at the end of three months.

The chemicals used all showed very little effect on the underground portion of the plants and could not therefore be considered effective as for success it is required to rid the land completely of living banana material within three months. Active nematodes were found in banana roots four months after the application of experimental treatment.

(iv) **Navel Removal — St. Catherine Plains:** Observations were made in a plant field on the St. Catherine Plains. Twenty plants were selected from the numbers shot during each of the following weeks — W/E 22/7/61, 29/7/61 and 5/8/61. The navels from 10 plants in each group were removed on 14/9/61. Records were taken on the number of days to reaping, the weight of stem, the length of the outer curvature of the middle finger on the 2nd hand from the "butt" end and also the 2nd hand from the "tip" end.

There were no significant differences between the "navel-removed" plants and the control within any of the weeks, for any of the records taken. No shortening of the fingers was observed nor was there any malformation of the stems of fruit.

### Variety Comparison

This is a straight yield comparison between Lacatan and Robusta planted on Belfield Clay at the Orange River Station in June. The observation consists of 100 roots of each variety. Fifty roots of each were planted at 9' x 9' spacing and the other 50 roots at 10' x 6'.

## REPORT OF PLANT PATHOLOGIST

D. S. Meredith

### Introduction

The Plant Pathologist was on overseas leave during the period 16th October, 1961 to 6th January, 1962. During that period he worked for varying periods at Long Ashton Research Station, University of Bristol and at Rothamsted Experimental Station. A brief report on this leave period was submitted.

In January, 1961, the Plant Pathologist visited various United Fruit Company Laboratories in Panama and Honduras. A special report, concerning boxing of fruit, methods of controlling fruit rot and other aspects of banana research, was submitted.

The year's research has chiefly concerned the biology of fungi associated with banana disease. Most of this work has been published already, or is in the press (Meredith, 1961).

### *Cordana musae*

In Jamaica and the majority of other banana-growing countries, **Cordana** leaf spot is generally of minor economic importance; serious outbreaks have been recorded for Surinam and Queensland.



It was observed that spores of *C. musae* are violently discharged under conditions of decreasing vapour pressure (Meredith, 1962). An automatic volumetric spore trap (Hirst, 1952) was operated in banana plantations to assess the frequency of air-borne spore of *C. musae*. An attempt was made to correlate fluctuations in spore concentration with time of day, weather and plantation conditions.

Sampling was almost continuous for the periods 20th July, 1960 to 18th February, 1961, 15th March to 15th April, 1961, and 4th August to 9th September, 1961. For the first 2 periods, the trap was operated in plantations of Lacatan bananas situated on the low-land plains in St. Catherine; the trap was placed in between the plant rows (4 m. apart) with its orifice 3 m. above ground. The incidence of leaf spot disease due to *Mycosphaerella musicola* was very low. *Cordana* leaf spot, although present in all plantations sampled, was of negligible economic importance. During the third period, the trap was operated at the Banana Breeding Station, Bodles, in a plot containing several different clones. To ensure maximum spore concentrations, the trap was placed 0.5 m. from the lower leaves of a 'mat' of plants displaying symptoms of *Mycosphaerella* and *Cordana* diseases; the trap orifice was 1.5 m. above ground.

Daily records of temperature, R.H. and rainfall were obtained from instruments placed near the trap. Regular and well defined diurnal periodicity was evident. Rapid spore liberation started near 06.00 hr., reaching a peak between 07.00 and 08.00 hr. There were a few days when small numbers of spores were found later than 16.00 hr. or earlier than 06.00 hr., but these were exceptional. The period of most rapid liberation corresponded quite closely with that of increasing temperature and decreasing relative humidity. Sometimes on damp, cloudy mornings the relative humidity did not decrease markedly until 09.00 hr. Correspondingly, the peak spore concentration occurred at about that time, that is, later than usual.

A typical example of variation in absolute numbers of spores is given for 9th August, 1961; concentrations recorded at 06.00, 07.00, 08.00, 09.00 and 10.00 hr. were 200, 1170, 810, 100, and 20 spores per  $m^3$ , respectively, none being trapped before 06.00 hr. or after 10.00 hr. Whenever more than 500 spores were counted for the 24 hr. period, over 80% were recorded between 06.00 and 10.00 hr.

Daily mean concentrations rarely exceeded 20 spores per  $m^3$  in St. Catherine. On many days during predominantly dry spells, no spores appeared on the traces. These meagre counts could not be closely related to fluctuations in weather conditions; however, the highest concentrations recorded invariably occurred after rain or irrigation.

Markedly higher spore counts were recorded at Bodles. During the period 5th August—3rd September, days having rain, or on which irrigation was carried out were usually followed on successive days by varying increases in spore concentration. Even a trace of rain in the afternoon, as on 8th, 16th and 23rd August, was usually reflected in an increased concentration next day. With few exceptions, nights when humidity exceeded 95% R.H. for 5 hr. or less were followed by concentrations lower than 25 spores per  $m^3$ ; periods exceeding 8 hr. were followed by counts of 50-160 spores per  $m^3$ . Analysis showed a significant positive correlation between number of hours of R.H. above 95% and daily mean spore concentration (correlation coefficient  $r=+0.86$ ). The highest hourly estimate recorded up to 3rd September was 1370 spores per  $m^3$  at 07.00 hr. on 8th August.

*C. musae* appears to be a minor component of the air spora in St. Catherine banana plantations. This was not surprising considering the low incidence there of *Cordana* leaf spot and, hence, the small inoculum reservoir. It was not possible, as it was originally hoped, to extend these spore trapping studies into a study of the epidemiology of *Cordana* leaf spot in St. Catherine. Even at Bodles, where some of the senescent lower leaves of susceptible varieties were diseased, regular application of fungicidal sprays effected good control of disease on the upper younger leaves. Thus again it was not possible to relate fluctuations in atmospheric spore load to disease outbreak. Stahel (1934) observed that 'clear nights during the rainy season, . . . , are very suitable for the spreading of these diseases, owing to the heavy formation of dew'. Two major factors are probably responsible for this. Firstly, the amount of inoculum available for infection increases under such conditions; secondly, high humidity at the surface of the leaf for 10-12 hr. is necessary for conidium germination and subsequent infection (Stahel, 1934).

#### Air-spores in Banana Plantations

Earlier studies (Meredith, 1961, 1962) dealt at some length with spore dispersal in *Deightonella torulosa*, the cause of 'speckling' *Cordana musae*, *Nigrospora* spp. and *Botryodiplodia*

**theobromae.** A more extensive survey of the plantation air-spores was made with the object of elucidating the dispersal behaviour of other banana pathogens.

The air in several Jamaican banana plantations was sampled from July 1960 to September 1961 with an automatic volumetric spore trap (Meredith, 1962). In dry weather, many fungi showed typical diurnal periodicity. Group I fungi (*Deightoniella*, *Nigrospora*, *Cordana*, *Corynespora*, *Zygosporium* and *Zygophiala*) first appeared shortly after 06.00 hr., reached a peak before 09.00 hr. and then showed a rapid fall. Group II fungi (*Cladosporium*, *Alternaria*, *Curvularia*, *Cerebella*, *Pithomyces*, *Periconiella*, *Menoniella*, *Ustilago* and others) and pollens had peak concentrations between 09.00 and 14.00 hr. Groups I and II formed the majority of the spore catch during daylight, but they were practically absent between 20.00 and 06.00 hr. Group III fungi (represented chiefly by ascospores, especially of *Leptosphaeria* spp., basidiospores and splash-dispersed types) first appeared near 20.00 hr., attained a maximum between midnight and 06.00 hr. and a minimum during daylight. In dry weather, *Cladosporium* conidia accounted for 23% of the total catch; coloured fusiform spores for 18%; coloured basidiospores for 16%; unclassified minute spores (including *Sporobolomyces*) for 14%; and *Deightoniella* only 0.2%.

During rain, the typical dry-air spora decreased and was replaced to varying extents by Group III ascospore types and splash-dispersed spores. When, after rain, the plantation dried out during daylight, Group III fungi decreased while Groups I and II briefly reappeared before the typical nighttime flora developed. When rain was continuous during daylight, Groups I and II were rare; ascospores and splash-dispersed spores dominated the traces. All fungi occurred in low concentrations during heavy rain, period of drought and strong wind. With rain or under-tree irrigation or both, the following days had varying increases of all Group I fungi and certain Group II fungi.

*Mycosphaerella*-type spores (Group III) were widely interpreted to include elliptical or cylindrical, tapering, 1-septate, hyaline spores, measuring 10-25 x 3-7  $\mu$ . *Mycosphaerella* sp. recorded on banana leaves are *M. musae*, 12-13 x 2  $\mu$  (Wardlaw, 1935), *M. minima*, 20-22 x 5-6  $\mu$  (Stahel, 1937) and *M. musicola*, 14-18 x 3-4  $\mu$  (Leach, 1941). At Bodles, form falling within each of these size categories were abundant on diseased banana leaves. It seems likely that one or more of these species were represented on the slides, but it is also probable that some 2-celled spores not belonging to the genus were included in the group. Periodicity was smaller to that for fusiform spores; wetting of mature asci by dew may account for this (Leach, 1941; Calpouzos, 1955).

Spores included in the *Glomerella* group (Group III) were indistinguishable from ascospores of *Glomerella cingulata*, perithecia of which are common on decaying banana leaves. *G. cingulata* is thought to be the perfect stage of *Gloeosporium musarum*, the cause of various form of banana fruit rot (Wardlaw, 1961; Meredith, 1961). Peak concentrations occurred near 04.00 hr.

Little was learned about the dispersal of fungi thought to be disseminated by rain splash. Many of the small hyaline spores trapped at night and during rainy spells may belong to this category, but there are few clues to aid identification. On the other hand, conidia of *Gloeosporium musarum*, thought to be splash-dispersed (Simmonds & Mitchell, 1940), are readily identified. They were often trapped during or after rain, but hourly concentrations never exceeded 200 spores/m<sup>3</sup>. This was surprising in view of the abundance of acervuli of this fungus on decaying banana leaves (Meredith, 1962). It has been suggested (Gregory & Hirst, 1957; Gregory & Stedman, 1958) that the efficiency of the Hirst trap in catching splash-borne spores is low due to the inability of large water droplets to penetrate the slit orifice. Further evidence that *Gloeosporium musarum* is splash-dispersed was obtained on two occasions at Bodles when driving rain and the absence of the trap rain-shield resulted in the cylinder becoming half-filled with rain water. The slide was partly immersed in this water and large numbers of *Gloeosporium* conidia were trapped on it. Also abundant were conidia indistinguishable from those of *Cercospora musae*, the imperfect stage of *Mycosphaerella musicola*; these were the only occasions when *Cercospora*-type conidia were trapped.

These aerobiological studies allow the following conclusions to be drawn:

1. *Deightoniella torulosa* and *Cordana musae*. Spores of these fungi are present in the atmosphere throughout the year. Peak concentrations occur after rain or Under-tree irrigation, due to the favourable effects of such conditions on sporulation. Each day, the peak load of these fungi occurs between 08.00 and 11.00 hr. These observations are consistent with the fact that *Cordana* leaf spot and *Deightoniella* fruit spot are most severe during and after rainy periods.



2. Fruit-rot organisms — *Gloeosporium musarum* (*Glomerella cingulata*), *Botryodiplodia theobromae* and *Ceratocystis paradoxa*. The two latter fungi are uncommon members of the air-spora and this may account for their infrequency on fruit-rots in storage. *Gloeosporium* conidia appear to be dispersed by rain splash thus accounting partly for the seasonal variation in fruit rot (Meredith, 1960).

3. *Mycosphaerella musicola* causing Sigatoka. Ascospores of the *Mycosphaerella*-type appear in large numbers when atmospheric humidity is high, that is, at night or whenever there is rain. The imperfect stage, *Cercospora*, appears to be splash-dispersed.

Due to difficulty in identifying small hyaline conidia, *Verticillium theobromae* (associated with various finger-tip infections, Meredith, 1961 h) was overlooked. The mucilaginous nature of its conidia suggest splash-dispersal.

#### Microflora of Decaying Banana Leaves

Many different fungi have been recorded on decaying banana leaves (Wardlaw, 1961) but the writer is unaware of any previous attempt to elucidate the pattern of fungi colonization of this substrate. Several of the associated fungi are parasites of the banana plant, and it is with some of these pathogens that one research project was concerned.

Leaf samples were collected from September 1960 to July 1961, chiefly from plantations situated in St. Catherine. All observations recorded here were made on the Lacatan variety of banana.

Leaf samples were incubated for 2-4 days inside a damp chamber and then examined microscopically for the presence of sporing fungi. It was realized that the picture of colonization obtained by direct examination might differ appreciably from that given by cultural studies. Fortunately however, the fungi in which special interest was held are prolific spore formers on this substratum.

| Fungus                           | Banana diseases caused by fungus<br>in Jamaica                                        |
|----------------------------------|---------------------------------------------------------------------------------------|
| <i>Gloeosporium musarum</i>      | Storage and transport rots of fruits                                                  |
| <i>Botryodiplodia theobromae</i> | Storage and transport rots of fruits                                                  |
| <i>Deightonella torulosa</i>     | Spotting ('speckle') and 'black-tip' diseases of fruits, 'black-spot' of leaves       |
| <i>Verticillium theobromae</i>   | Various finger-tip infections of immature fruits                                      |
| <i>Cordana musae</i>             | Leaf-spot disease                                                                     |
| <i>Fusarium</i> spp.             | Various finger-tip infections and storage and transport rots of fruits; root diseases |
| <i>Mycosphaerella musicola</i>   | Leaf spot disease (Sigatoka).                                                         |

Rotting of the proximal end of the petiole commences a few days after collapse, originating at the point of doubling over. Sometimes the distal end of the midrib has died and become colonized by fungi before collapse occurs. Local lesions may be present on the edge of the midrib at points where the lamina has been partially torn away by wind action and, also, where adjacent lamina tissue has died prematurely. Out of a total of more than 200 samples examined, *Verticillium theobromae* was found to be the most frequently occurring fungus near the point of doubling over. Colonies of *Nigrospora*, *Deightonella torulosa*, *Pyricularia musae* and *Gloeosporium musarum* were also common in this region; *Fusarium* spp. and *Memnoniella subsimplex* were rarely present. Marginal lesions contained several fungi of which *Deightonella torulosa* was usually the dominant species; *Nigrospora*, *Verticillium theobromae*, *Fusarium* spp. and *Cephalosporium* sp. were common, but *Pyricularia musae*, *Cordana musae* and *Memnoniella subsimplex* were infrequent. Decay towards the distal end of the midrib was associated with *Verticillium theobromae* (often the dominant species), *Pyricularia musae*, *Deightonella torulosa*, *Nigrospora* and, more rarely *Gloeosporium*.

In older collapsed leaves, almost the complete surface area of the petiole and midrib was colonized. Out of a total of 560 leaves examined, the following fungi were recorded with the indicated frequencies: *Pyricularia musae* 100%, *Verticillium theobromae* 100%, *Nigrospora* 100%, *Deightonella torulosa* 100%, *Gloeosporium musarum* 82%, *Fusarium* spp. 22%, *Cordana musae* (usually in localized lesions confluent with *Cordana* spots on the lamina) 6%, *Botryodiplodia theobromae* 3%.

In one sample of 45 leaves it was estimated that *Pyricularia musae* occupied more than 30% of the total colonized area on the convex surface of the petiole and midrib. Next in

abundance were *Gloeosporium musarum* (c. 30%), *Deightoniella torulosa* (c. 20%), *Nigrospora* (c. 15%) and *Verticillium theobromae* (c. 10%). *Verticillium theobromae* and *Nigrospora* were particularly common at the distal end of the midrib and at the point of doubling over of the petiole. *Deightoniella torulosa* and *Nigrospora* were usually the dominant species along the edges of the midrib at the point of attachment of the lamina.

All of the above-mentioned fungi were recorded on the concave, adaxial surface of the petiole and midrib, *Nigrospora*, *Deightoniella torulosa* and *Gloeosporium musarum* being particularly common.

On yet older leaves, the primary colonists were still in evidence but, with the exception of *Verticillium theobromae* and *Nigrospora*, spore production was less prolific than on more recently collapsed leaves. The oldest and very dry leaves were characterized by an abundance of *Verticillium theobromae*, *Zygosporium oscheoides*, *Fusarium* spp., *Memmoniella subsimplex*, *Cladosporium* sp. and many other hyphomycetes. A few sporing colonies of *Pyricularia musae* and *Deightoniella torulosa* were present but, in the majority of cases, colonies of these two fungi were overgrown by *Verticillium theobromae* and other species. *Nigrospora*, although less common than on younger leaves, was still sporulating quite abundantly. *Curvularia lunata* and a species of *Alternaria* were sometimes recorded.

Samples of leaf tissue showed that the more important primary colonizers were *Verticillium theobromae*, *Deightoniella torulosa* and *Nigrospora*. All of the fungi named in preceding paragraphs were also recorded at various times. It was observed that soon after the lamina became desiccated the primary colonizers decreased in abundance, being replaced by forms belonging to the genera *Cladosporium*, *Aspergillus*, *Cephalosporium*, *Alternaria*, *Paecilomyces*, *Fusarium*, *Penicillium* and others.

Initial decay of the upper portion of the sheath was associated with *Verticillium theobromae* (often the dominant fungus), *Deightoniella torulosa*, *Pyricularia musae*, *Gloeosporium musarum* and *Nigrospora*. There was a sharp line of demarcation between healthy and decayed tissue. As the primary colonists progressed down the sheath they were replaced in the upper regions by species of *Leptosphaeria*, *Fusarium*, *Cladosporium*, *Cephalosporium*, *Aspergillus*, *Paecilomyces* and others. Of the primary colonists, *Verticillium theobromae* and *Nigrospora* were usually the last to disappear.

A search was made for undischarged acervuli of *Gloeosporium musarum* on collapsed leaves. The frequencies recorded were as follows: leaf 1, 10%; leaf 2, 70%; leaf 3, 75%; leaf 4, 25%; on leaves 5-n only discharged acervuli were present. Thus peak spore production in this fungus took place during the early stages of decay and desiccation. When pieces of petiole bearing discharged acervuli were incubated for 10-12 days in damp chambers there was no renewed sporulation by the fungus. It was concluded that, on any given plant, only the three or four most recently collapsed leaves were important as sources of inoculum of *Gloeosporium musarum*.

The relation between age of collapsed leaf and spore producing capacity of *Deightoniella torulosa*, *Nigrospora*, *Pyricularia musae* and *Verticillium theobromae* was investigated. Lengths of petiole and midrib bearing colonies of these fungi were cut from leaves 1-10 on each of ten replicate plants. Each length was thoroughly washed, allowed to dry and then incubated for 10 days inside a damp chamber. (As a result of this treatment, very few spores remained on the host surface and in no instance were conidia found attached to their respective conidiophores). After incubation it was found that *Deightoniella torulosa* and *Pyricularia musae* underwent abundant renewed sporulation on leaves 1-3 and that there was a progressive decrease in spore production on successively older leaves. On leaves 8-10 there was no renewed spore formation. In contrast, *Verticillium theobromae* produced large numbers of new conidia on leaves of all ages. *Nigrospora* sporulated abundantly on leaves 1-6, falling off appreciably on older leaves.

High external humidity is essential for sporulation of *Deightoniella torulosa*, *Nigrospora*, *Pyricularia musae* and *Verticillium theobromae*. Thus, no sporulation occurred when lengths of infected petiole tissues were maintained at 95% R.H. Wetting the tissues and incubating in a saturated atmosphere provided optimal conditions. Peak spore production under natural conditions took place after rain or irrigation, certainly in the cases of *Deightoniella torulosa* and *Nigrospora*.

The fact that certain of the pathogens discussed here are also common saprophytes on decaying banana leaves has important practical implications so far as the control of various banana diseases is concerned. Working in Queensland, Simmonds & Mitchell (1940) found



a significant correlation between the number of dead leaves per plant and the incidence of anthracnose (*Gloeosporium musarum*) and 'black-end' disease (*Gloeosporium musarum*, *Fusarium* spp. and *Nigrospora sphaerica*) in marketed fruit. They regarded this as confirmation of plantation observations indicating that dead and dying leaves comprise the most important source of inoculum of these fungi. It was recommended that trash should be removed from plantations at least three times a year to reduce the incidence of these two diseases, and of 'squirter' disease. Leach (1946) drew attention to the potential danger of trash in regard to infection by *Mycosphaerella musicola*. He recommended the removal of trash from Jamaican plantations before the autumn rains or, if this was impracticable, to heap the trash and to cover it with weeds. It seems desirable to investigate in Jamaica the possible benefit of de-trashing on the incidence of commercially important diseases such as *Gloeosporium* fruit rot, *Deigh-toniella* fruit spot and *Verticillium theobromae* infections. There is already evidence that the atmospheric content of *Deigh-toniella torulosa* spores is markedly reduced by good plantation hygiene (Meredith, 1961).

### Fruit Rot Control

Commercial scale experiments were started in 1961 to test Dithane M22 (Maneb, manganese ethylene bisdithiocarbamate) as a possible control treatment for storage rots of bananas. Bunches of fruit were treated at Bowden wharf by immersing in Dithane (2 lb. per 100 gall. water plus 4 oz. Triton X-114) for 30-60 sec. Reports obtained to date have yielded few data on the effect of the compound on anthracnose (*Gloeosporium musarum*) or finger-stalk rot (*S.M.S.E.R.*, *G. musarum* and other fungi). On the other hand, there was evidence that main-stalk rot was completely controlled by Dithane.

### Leaf Spot Control

Experiments designed to compare the effects of various oils on leaf spot and initiated by R. Leach were handed over to the Plant Pathologist. According to data collected up to July 1961 at one site there was no significant difference between Esso 3156 and Shell Vapona E. Although at another Esso gave better control of leaf spot than did Shell. There was no justification for concluding that one product was markedly superior to the other.

Other experiments were discontinued.

### Conclusion

The aerobiological studies and the study of the microflora of decaying banana leaves have shown that all of the organisms causing storage rots of bananas are present on debris in the plantation. Spores of some of these fungi are abundantly disseminated by wind alone, but others are splash-dispersed. Thus from its earliest development after shooting, the bunch of fruit is exposed to these organisms which, to varying extents, are trapped thereon.

It is suggested that extensive detrashing of plantations should be carried out in order to minimize these inoculum sources. It was shown as early as 1935 by Australian workers (Simmonds & Mitchell, 1940) that good plantation hygiene caused a marked reduction in the incidence of 'squirter' disease (*Nigrospora* spp.) and other forms of fruit rot. Fungicidal treatment of fruit after harvesting is sometimes beneficial, (Meredith, 1960, 1961) but all too frequently is not so. Tackling the problem at an earlier stage — in the plantation — may well give improved control. Future investigations will concern various methods of reducing field inoculum sources, for instance, phytosanitation, bunch spraying with fungicides and testing anti-sporulation fungicides on trash.

## REPORT OF THE EXECUTIVE FIELD OFFICER

W. G. Chambers

### Banana Nematodes

(i) **Extension:** The results of intensive investigations done previously by a departmental nematologist (Leach, 1961) on the burrowing nematode were applied in a programme of training field staff of the All Island Banana Growers in the technique of freeing suckers of nematodes preparatory to planting. Demonstration of the method was also made on several occasions to individuals and groups of farmers.

(ii) **Nursery:** Progress was made in the establishment of the experimental "clean" sucker nursery at Bodles. In January removal of suckers for planting the second stage was commenced

and from the original 1200 mats 3300 suckers were obtained by the end of March. Approximately 3% of these showed lesions due to *Radopholus*.

In August planting material was available from the second stage nursery for planting observation plots and 1900 were dug before the end of the year.

Preparations were made for another nursery at Orange River. Land on which there had been no bananas for over six months was ploughed and made ready for planting in October and one acre fenced off for the nursery. It was then arranged to have the suckers supplied by the Bodles nursery.

(iii) **Observation Plots:** Of the fifty plots planned (Leach, 1961) sixteen were planted during the year. On each of these

50 suckers completely free of nematodes (stage 2)

100 suckers of standard banana growing practice

were set out on land considered 'clean' of *Radopholus* by virtue of not having grown bananas for at least six months. Plans were made for yield comparisons and recording of the rate of entry of burrowing nematode on the clean plantings.

### **Orange River Station**

Land was made available by the Ministry of Agriculture and Lands at the Orange River Agricultural Station in February for the use of the Department to carry out field experiments with bananas. The area consists of approximately 55 acres on most of which there were bananas growing in varying stages of ratoon.

With the exception of two fields all existing Lacatan was dug out and the land left to fallow so as to starve out *Radopholus*; these two fields were used for experiments on Nitrogen Uptake and Crop Timing by the Crop Physiologist and Banana Killing by the Agronomist. Other banana fields left standing were Seedling Observation Plots of the Banana Breeding Research Scheme.

During the year new seedling banana plots were planted by the Plant Breeder and a Lacatan-Robusta yield comparison trial laid out by the Agronomist on a small area.

Administrative responsibility for the station was initially given to the Agronomist and was transferred to the Executive Field Officer at the beginning of November.

## **REPORT OF THE PLANT BREEDER**

**R. E. Osborne**

### **Administration**

An additional Technical Assistant was appointed at Bodles to assist primarily with the diploid and triploid programmes, as well as experiments on pollination and germination techniques. The Plant Breeder was on vacation leave in the United Kingdom and visited various research institutions.

Extension of the ripening rooms at Bodles has been completed and necessary repairs done to other buildings at Bodles and Rhymesbury.

Notable visitors during the year included Dr. Moulton O. Thomas attached to United Fruit Company breeding research unit at La Lima; he spent more than a week. Others were Drs. Phelps and Green of United Fruit Company; Mr. N. W. Simmonds and Mr. D. A. Perryman, members of the Scientific Advisory Committee on Banana Breeding Research.

### **Pollination**

Emphasis continued to be placed on the use of Highgate as female parent in the production of tetraploids at Rhymesbury. Losses in Gros Michel from wind damage were 333 trees. Seed yields from both parents were poor, with Highgate yielding half as many as Gros Michel. Details of pollinations and yield of seed are given in Appendix P.B. 1.

The production of triploids was started based on crosses of the best diploids available with the best tetraploids. During the period under review 157 bunches have been pollinated. Details are given in Appendix P.B. 1 together with data on tetraploids.

A spacing-fertility trial was started to determine the effect of fertilizer treatments on seed production of Gros Michel and Highgate. Two fertilizer treatments were used:  $N_1$  - 10:5:20 applied at the rate of six pounds per mat in four equal instalments,  $N_0$  - 0:5:20 applied at the rate of two pounds and fourteen ounces per mat in four equal instalments. Two spacings were used - 11ft x 2ft and 11ft x 6ft.

The lay-out was a Randomized Block Design with five blocks of two plots each and each



plot split for spacing. The trial aims at regulating plant growth by varying nutrient applications and population density.

### **Greenhouse and Germination**

Details of seed planted, germinations and seedlings potted have been given in Appendix P.B. 2. No Gros Michel or Highgate seeds were sown in September since previous experience has been that such seeds are unlikely to give a satisfactory tetraploid yield. It has yet to be decided what the policy will be with regards to such seeds. Under the cytogeneticist's report is given a detailed account of germination experiments and observations.

### **Nursery**

180 tetraploids were planted out during the year; of these 56 were of the Highgate cross. After selections were made a total of 222 tetraploids remained in the nursery. In addition 37 triploid seedlings were planted out and all remain in the field. Details are given in Appendix P.B. 3.

### **Panama Disease Testing**

The peculiar behaviour of tetraploids at Bodles with susceptibility to Panama disease, has persisted and the problem will be fully investigated. A very high proportion of seedlings contracted Panama disease in the Nursery and seedlings selected in the nursery, during the period under review have subsequently shown a high degree of susceptibility to Panama disease in the Field Test Plot. In Appendix P.B. 4 details are given.

### **Observation Plots**

(i) Thirty Root: Only two clones have been retained in 30-root observation plots. No new clones were selected during the year for observation.

(ii) Windward Islands: Fruit from the plant crop have been seen and the results have been very similar to those obtained in Jamaica. The plots will be maintained in order to see the first ratoon crop.

(iii) Cameroons: Suckers of 8179-2 have been sent to the Cameroons from Kew; 8987 has been discarded subsequently.

(iv) Extended: Clone 2390-2 has now been discarded as the fruit was too poor to be commercially acceptable. Extension of 8179-2 was done to obtain fruit but the weakness of this clone to "break-neck" has delayed further extension. One other clone, 10648, is being extended to observe fruit behaviour.

### **Half-Acre Observation Plots**

Fruit of 1847 was seen from all but one of the twelve plots during the year. Fruit quality has been variable with hillside plots producing the best results. At one plot in St. Thomas, there were cases of Panama disease and all the plants were dug out and destroyed. There have been no cases of Panama disease at any of the remaining plots.

Further large scale commercial testing of the clone will now be done to determine the suitability or otherwise for the export market.

### **Suckering Comparison**

The results have shown that tetraploid clone 1847 is not inferior to Lacatan in the production of suckers. Furthermore, the frequent removal of suckers results in the largest production. It does not seem to matter whether or not the leaf bases are removed, as in the Barker method.

### **Shipping Trials**

Two trial shipments, totalling 201 stems of 1847, were made. The reports showed that the ripened appearance of the fruit was good; the texture was firm and the taste not quite as sweet as Lacatan. Finger size and strength of peduncle were acceptable but there was a tendency for the fingers to fall away when ripened. This feature will be examined more carefully with future shipments.

## REPORT OF THE CYTOGENETICIST

K. Shepherd

### Seedling Production in A Series

Summaries of yields from different groups of female parents in A series (diploid breeding programme) are given in Appendix Cyto.1. Seed yields in Samoa hybrids have been much in excess of expectation, often many hundreds or over a thousand in a single bunch.

Germinations in some categories were consistently poor and crosses involving 4053 selections as female parent were eventually suspended. Otherwise germinations in boxes were inconsistent and patchy and it was concluded that drainage was often impeded. Experiments to remedy this, and on the basic requirements for optimal germination of seeds from edible types, are reported below. Modification of the greenhouse layout provided more uniform conditions at the end of the year.

### Families in the Field and Selections

The majority of seedlings planted were of Tongat crosses, but there were also some new Samoa hybrid families and, towards the end of the year, an increasing diversity of parentages.

Useful segregates occurred in two out of three Tongat hybrid families which were flowering. Selections were also made from some miscellaneous small families. Most of the selections transferred from Trinidad were reviewed critically and expanded plantings were made of several at both Rhymesbury and Bodles.

### Seed Yield Experiments

(i) **Age of Pollen:** These trials compared pollen from flowers over a narrow age range, from the oldest unopened bract to one which had been open for several hours but was still adhering. Three pollen ages were applied to plots within hands of three triploid (ABB) edible bunches and one of wild *M. acuminata*: a suitable clone of the latter was used as a pollen source.

The data revealed mainly that pollen of all ages could be effective on nearly sterile bunches, but it also seemed that pollen from immature flowers was less effective.

(ii) **Growth Active Substances and Time of Application:** Three series of trials were made with solutions painted on ovaries, either at flower receptivity (time 2) or one day previously (time 1). The limitations of material restricted trials to one substance at a time, treatments assigned to plots within hands and replicated within bunches. Aqueous solutions were used with minimal amounts of ethanol as a co-solvent and teepol as a spreader. Female fertile diploid and triploid clones were used; the substances applied in separate trials were 1000 ppm. thiourea, 100 ppm. indole-butyric acid and 100 ppm. gibberellic acid. Results are shown in Appendix Cyto.2. Where there have been suggestions of beneficial effects, these have not been consistent between clones used.

Further trials were initiated with these and other substances, limited to one time of application.

### Germinations — Observations and Experiments

(i) **Germination of Gros Michel seeds:** The analysis continued of Bodles routine records in the hope of identifying factors determining good germination. The summary of seasonal performance, referred to in the Annual Report 1960, was completed and data are presented in Appendix Cyto.3. As well as the overall figures for seeds sown in a given month, details are given for 1955, an unusually successful year, which illustrate the levels of efficiency that can be attained. It is recognized that the differences may be partly or wholly caused by physiological differences in seeds reaped at various seasons. However, there has yet been no opportunity to test this and, since the germination environment is more readily investigated, this is being done.

Except at the very best and the very worst periods, the records indicate clear discrepancies between fresh seed sowings made within a week or even a few days of each other. Unsatisfactory sowing media may have been a cause, or, as more recently suspected, uneven exposure to the sun's heat.

Efforts have been made to compare the greenhouse performance of crosses with different male parents. The most critical comparisons made are listed in Appendix Cyto.4. It was usually necessary to sun sowings over several months and the only means of weighting was to separate winter and summer results; therefore the apparent differences must be regarded with



some caution. In the last case, the families 7510L, 8046E and 8058A are of virtually identical parentage and a real difference in germination performance would be surprising.

A further complication arises from a possible inverse correlation of germination rates with seed yields per bunch. Some data suggested that seeds from highly fertile bunches germinated less readily than the norm and yielded relatively fewer tetraploids. This needs confirmation.

(ii) **Temperature effects:** Since germination of Gros Michel and Highgate seeds had been found to be grossly affected by some seasonal factor or factors, an experiment was set up in January to assess the effect of increasing day and night temperatures, separately or together, above the greenhouse norms. Higher day temperatures were achieved by putting pots in the open sun, night temperatures by means of a box heated intermittently by an electric light bulb. Until it broke down in mid-April (after 80 days) the box achieved a fairly steady temperature, usually between 80° and 84°F at 6.30 a.m. compared with an average of about 70°F in the greenhouse. The open sun-greenhouse day differential, based on 1.00 p.m. readings at half an inch depth in pots, averaged about 6.5°, and the mean maximum temperatures are estimated as about 105° in the sun and 98° in the greenhouse. All greenhouse and sun temperatures showed upward trends during the experiment and outside pots from April were doubtless baked at temperatures up to 120°F for part of the day, obviously unfavourable conditions for young seedlings and probably for germinating seeds. A fifth treatment was kept at 75° ± 2°F for 80 days and then transferred to the greenhouse-sun combination.

The seeds of cultivar origin, then available in sufficient quantity were from the diploid clone Tongat and triploid clone Awak Legor. The latter, with a high proportion of tetraploid progeny, would have been more relevant, but unfortunately the seeds were not fresh and none germinated. The Tongat seeds germinated poorly enough but the differences seem clear as Appendix Cyto.5 shows. The experiment was finally discarded after six months but from 81 days on, all pots were in the greenhouse at night.

Exposure to sun promoted germination at first, even in the fifth treatment, but increasing day temperatures finally suppressed it. No germinations occurred at the constant temperature tried nor in the other treatment where the maximum-minimum differential was less than 20°F. This confirms the finding of Stotzky *et al.* (1961), working at Norwood, that a temperature differential is necessary for the germination of *Musa balbisiana* seeds. But they also find that optimal temperatures are 18°C (64.4°F) minimum and 32°C (89.6°F) maximum, considerably lower than the above experiment would indicate.

It is essential for further trials to be able to control temperatures more precisely and it is hoped that facilities for this will be available early in 1962.

(iii) **Temperature records:** Maximum-minimum thermometers were installed in shade near the office and in the smaller greenhouse at the end of March, and in the large greenhouse in early August. Some meaningful pattern may emerge with time but there has been rather little difference between monthly means for maximum, minimum or differential. However, temperature differentials seemed to be more consistent in the mid-summer months, rarely more than 27°F or less than 20°F.

(iv) **Seed Storage:** The accepted manner of storing banana seeds has been in a desiccator at ambient temperature. Simmonds (1952) found that *Musa balbisiana* seeds germinated well after two years of such storage, but that they failed within a year with laboratory storage, even if well dried before storage. He also stored *M. acuminata* seeds in a refrigerator with fair success for up to one week. Stotzky and Goos (unpublished) found that storage at 6°C was better for *M. balbisiana* seeds than desiccator storage at room temperature, provided that the seeds were soaked for 48 hours, but no longer, before sowing.

As storage presented an alternative solution to the winter sowing problem, an experiment was set up in January using two lots of secondary triploid seeds (B series), the only ones available. These seeds had already been stored in a desiccator for approximately four months and both lots had been proved viable when fresh. Cross B4 had yielded 15 germinations from 144 seeds in a September 1960 sowing. B11 gave 10 germinations out of 50. However, B4 failed to germinate in any experimental treatment, a total of 300 seeds, so that desiccator storage was obviously unsatisfactory in this instance.

Of 100 seeds of B11 sown on 11.1.61, 22 germinated, appearing between 27 and 158 days from sowing (19 within three months). 100 seeds stored in a refrigerator from 11.1.61 to 10.4.61 and then sown gave 25 germinations between 22 and 69 days; the box was discarded after 14 weeks. It was intended to sow 100 more seeds from the desiccator on 10.4.61 but,

by misunderstanding, they were not sown until 12.5.61. 15 germinated between 20 and 47 days; the box was discarded with the others on 18.7.61, after 9½ weeks, there having been no germinations for three weeks.

The results from one batch of seeds, unreplicated, cannot be regarded as significant but it seems that the refrigerator is at least as good a store as the desiccator.

(v) **Soaking Treatments:** Simmonds (loc.cit.) found that soaking seeds was ineffective or, if prolonged, was deleterious, while Stotzky & Goos (unpublished) found soaking beneficial to chilled seeds at least. Various workers have found that gibberellic acid (GA) and/or thiourea (TU) could break induced dormancy in lettuce seeds, and gibberellic acid has successfully promoted germination in *Carica papaya* (Lange, 1961).

Accordingly a 2x2x2 factorial experiment was set up with presence or absence of 200 ppm. GA, presence or absence of 1000 ppm. TU, and 7 versus 14 days' soaking. Soaking was done on a moist filter paper in petri dishes and the seeds were sown in sand in pots. Two additional controls were added of seeds sown directly in sand or in greenhouse soil. Five replicates were used, replicate E using a wild cross of a type in which germination problems would rarely arise; the others were A series crosses.

Results are shown in Appendix Cyto.6. Percentages were transformed to angles for an analysis of variance, in which the interaction of thiourea and duration and the second order interaction were both significant. It appeared that soaking with thiourea for one week had a beneficial effect. A further experiment was begun to confirm this.

(vi) **Sowing Medium:** As mentioned in section A above, erratic results have been obtained from sowing in boxes, even to the extent that seeds germinated freely in some parts of a box but not in others. Unhealthy growth of young seedlings was also conspicuous. Faulty drainage was suspected, resulting from one or more of three causes, the solid bottoms of the boxes, their shallowness, and excessive water retention in the sowing medium.

The last was examined experimentally in deeper than usual boxes which were provided with drainage holes. The mixture in normal use has consisted of two parts compost to one of sand. This was compared with equal parts compost and sand and with pure sand. Six replicates were used, four from A series and two wild crosses; one of the A series crosses failed to germinate, and the sand treatment of another replicate had to be discarded because of an error in recording.

The two mixtures were very nearly equal in total germinations after 12 weeks and in the growth and vigour of the seedlings. However, germination in the richer mixture was slower on average and patchy in some boxes. The wild-type seeds germinated most rapidly in pure sand but total germination was equal or inferior to the other treatments. Moreover, seedling growth was inhibited, not unexpectedly. With pricking off at a very early stage, sand might still be a useful medium.

(vii) **In vitro Culture:** Stotzky and his associates at Norwood (unpublished) have got rapid and numerous germinations from surface-sterilized chipped seeds of *M. balbisiana* plated on sterile sucrose agar, even when the seeds were otherwise dormant. Early attempts to utilize this technique have failed because of the difficulty, found also by Simmonds, of sterilizing seeds effectively and consistently. Calcium hypochlorite, sodium hypochlorite and mercuric chloride have all been used.

Trials with an alternative Norwood technique, for culturing dissected embryos, were deferred but some experience was gained in the dissection and plating of embryos. While laborious, this method has the advantage of being independent of temperature differentials.

## Fertilization Studies

The time available has been devoted chiefly to a mass search of ovule sections, to establish frequencies of embryo sac production and of arrivals of pollen-tubes within the ovule integuments, for a variety of clones. Data so far are shown in Appendix Cyto.7. The ovules from diploid clones were fixed in Trinidad and the post-receptive samples were taken two days after pollination. Those from Bluggoe and Ney Mannan at Bodles were taken three days after pollination.

The estimate of 'normal' embryo-sacs needs qualifications. Without technical perfection in handling the material, lost or damaged sections and sometimes faulty staining made interpretation of sacs less certain or even impossible. On one hand some were classified as normal when perhaps one or even two of the five expected nuclei were unseen, especially where



the egg apparatus was virtually intact. Particularly in the case of Sikuzani the minimum basis accepted was the presence of healthy egg and polar nuclei, whereas one or both synergids might be unhealthy-looking. On the other hand some at least of the many unclassified sacs were surely normal.

Two critical factors emerged more or less consistently. One was the high frequency of sacs which were already degenerate or unhealthy at the time of receptivity. This frequency was generally higher at the later sampling, and in Bluggoe such sacs accounted for at least 42 of the 62 examined at this later sampling.

The other factor was the rarity with which pollen-tubes were seen, none at all in fact in Sikuzani or Bluggoe. Both of these latter set seeds on occasion, Bluggoe even fairly freely. Two figures are listed here; the first is for embryo-sacs, the second for immature stages. There was evidently no regular mechanism to discourage the entry of tubes into bad ovules and they were even found in association with undeveloped dead megaspores. Of the two Paka embryo-sacs with tubes, one was apparently in the process of fertilization and the status of the other could not be determined. Of five in Tongat, two were in the process of fertilization, two were uninterpretable, one was certainly an abnormal sac with four polar nuclei and the tube had not penetrated. All three in Ney Mannan were fertilized embryo-sacs but the endosperm was degenerating in two.

Little new work was done on pollen tube growth itself, although the importance of this becomes increasingly clear. Hand sectioning is laborious and in the case of ovary apices extremely difficult. Even with semi-proficient technical assistance it has not been possible to examine many hands at a session.

Altogether 21 hands were examined in an effort to determine the effect of 100 ppm. gibberellic acid on promotion or suppression of tube growth and on tube growth rates. There was no tube growth, or virtually none, in five hands, all of them somewhat immature morphologically. The inference from the others, of Tongat, Paka and Samoa x Paka, was that GA applied to ovaries on the day before receptivity was very variable in effect, sometimes promoting, sometimes suppressing or retarding pollen-tubes. GA applied to styles on the day of receptivity, at the time of pollination, consistently retarded or prevented tube growth.

This answer is at odds with the evidence, slight though it is, from pollination experiments that GA on the day of receptivity may improve seed-setting. However, the difference in dosage between 100 ppm. applied to ovaries and 100 ppm. applied directly to styles is obviously a considerable one and may be significant.

### Species relationships and other cytogenetic work

The majority of possible species crosses had been studied on a small scale in Trinidad, and a small number more extensively. Those which may ultimately have practical importance are crosses of *M. acuminata* clones with allied species and it was thought worthwhile to examine more comprehensively the behaviour of some such crosses, especially in generations after the  $F_1$ . A major object was to compare the performance in crosses of various *M. acuminata* sub-species as they were already known to differ in this respect. Comparisons to be made were of vigour, fertility, meiotic behaviour, including chiasma frequencies, and segregations in  $F_2$  and backcross generations.

$F_1$  families of six different strains of *M. acuminata* with *M. schizocarpa* Simmonds have been raised and partly studied. Except for increased height and girth of the plants, morphological evidences of *M. schizocarpa* parentage were few. Specially interesting features were the type and extent of variability within two families, and the extreme differences between families in Panama disease resistance, although all strains of *M. acuminata* used as parents were themselves highly resistant.

Some species crosses were made with a recently acquired and hitherto undescribed species from Central India. Its fruits have repeatedly failed to set with alien pollen but reciprocal crosses were readily achieved with *M. acuminata* and other related species.

Study continued of reciprocal translocations in strains of *M. acuminata*. The forms from Kedah and Kelantan, classified by Simmonds (1956) in sub-species *siamea*, were found to have a chromosome structure very distinct from the Thai and Annam introductions. They are now regarded as an aberrant form of sub-species *malaccensis*.

Bunches of some East African triploid (AAA) clones were pollinated to determine female fertility and ploidy types in the progeny. Only Paji, Lujugira and Nandigobe have so far yielded seeds. The only seedling so far obtained has not had a chromosome count, but is thought to be an aneuploid.

## Introductions

The wild collections have improved greatly in appearance during the year and some forms previously on the point of failure are now well established. Some new cultivar identifications have been made. The Kenya clone Munjuu was found to be the common type of Maiden or French Plantain; Kisubi from Uganda was the same as Ney Poovan from Madras; Bakweri from the Cameroons differed from the widespread type Pome only in the transient red flush of the young peduncle and bunch axis. It was further confirmed that the East African clones Nandigobe and Nakitembe differed from Mitahatu (= Mutika) and Lujugira, respectively, only in their persistent neuter and/or male flowers, a character which was rarely shown in Trinidad conditions. The clone Ice Cream from the Pacific, a mystery for some time, appeared to be a waxy-fruited variant of Ney Mannan from Madras, perhaps the variant known there as Venneettu Mannam.

Efforts have continued to secure further introductions of potential value or special interest and the generous help of the Royal Botanic Gardens is acknowledged, as well as that of correspondents in many tropical countries.

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## APPENDIX

### Phys. 1. NUTRITION OF THE BANANA PLANT: PHOSPHATE UPTAKE EXPERIMENT

ST. THOMAS

Layout: 5 Randomised Blocks

Main Treatments:

1. Control
2. 1 lb. ammonium sulphate (21%N)/mat/year
3. 1 lb. di-ammonium phosphate (21%N, 53%  $P_2O_5$ )/mat/year

Sub-treatments:

- A. Control
- B.  $\frac{1}{2}$  lb. kieserite (27% MgO)/mat/year

Size of Plot: 6 mats

Leaf Analysis (Mean Value %)

| Constituent | 1A   | 1B   | 2A   | 2B   | 3A   | 3B   | A    | B    |
|-------------|------|------|------|------|------|------|------|------|
| N           | 2.91 | 2.76 | 3.22 | 2.92 | 2.86 | 2.89 | 2.93 | 2.86 |
| $P_2O_5$    | 0.36 | 0.37 | 0.39 | 0.38 | 0.42 | 0.42 | 0.39 | 0.39 |
| $K_2O$      | 3.25 | 3.94 | 3.92 | 3.74 | 3.68 | 3.64 | 3.62 | 3.77 |
| CaO         | 1.01 | 0.91 | 0.98 | 0.89 | 0.90 | 1.05 | 0.96 | 0.95 |
| MgO         | 0.41 | 0.40 | 0.41 | 0.43 | 0.44 | 0.47 | 0.42 | 0.43 |

Yield

|                  |       |       |      |       |       |       |       |       |
|------------------|-------|-------|------|-------|-------|-------|-------|-------|
| Total Stems      | 31    | 27    | 20   | 27    | 25    | 26    | 76    | 80    |
| Exportable Stems | 29    | 24    | 19   | 23    | 23    | 22    | 71    | 69    |
| Count Bunches    | 13.25 | 10.50 | 8.00 | 10.50 | 10.50 | 12.00 | 31.75 | 33.00 |

### Phys. 2 NUTRITION OF THE BANANA PLANT: PHOSPHATE UPTAKE EXPERIMENT

ST. MARY

Layout: 5 x 5 Latin Square

Planted August, 1960.

Leaf Analysis (% D.M.)

| Constituent | Initial | Mean Values for the Year |      |      |      |      |
|-------------|---------|--------------------------|------|------|------|------|
|             |         | A                        | B    | C    | D    | E    |
| N           | 4.31    | 3.77                     | 3.62 | 3.43 | 3.67 | 3.52 |
| $P_2O_5$    | 0.40    | 0.40                     | 0.44 | 0.47 | 0.46 | 0.47 |
| $K_2O$      | 4.27    | 4.44                     | 4.45 | 4.57 | 4.03 | 4.46 |
| CaO         | 0.81    | 0.58                     | 0.65 | 0.64 | 0.67 | 0.63 |
| MgO         | 0.38    | 0.50                     | 0.50 | 0.49 | 0.47 | 0.44 |

Vigour and Yield Data 1961 — Plant Crop

| Treatment | Mean Height at Shooting (ins.) | Per Cent Shot | Mean Bunch Weight (lbs.) |
|-----------|--------------------------------|---------------|--------------------------|
| A         | 77                             | 88.9          | 20.2                     |
| B         | 84                             | 84.4          | 25.8                     |
| C         | 85                             | 86.7          | 27.2                     |
| D         | 82                             | 73.3          | 23.2                     |
| E         | 85                             | 80.0          | 26.3                     |



**Phys. 3     NUTRITION OF THE BANANA PLANT: NITRATE UPTAKE EXPERIMENT  
ORANGE RIVER**

Layout: 8 Randomised Blocks

Treatments

1. Sulphate of ammonia 21%N                    — 4 oz/mat
2. Nitrate of soda                                 — 5¼ oz/mat
3. Ammonium sulphate nitrate 26%N         — 3¼ oz/mat
4. Urea 46% N                                     — 1¼ oz/mat
5. Control — no additional nitrogen

Leaf Analysis (% D.M.)

| Constituent                   | Initial | Mean Values for the year |      |      |      |      | L.S.D.<br>P = 0.05 |
|-------------------------------|---------|--------------------------|------|------|------|------|--------------------|
|                               |         | 1                        | 2    | 3    | 4    | 5    |                    |
| N                             | 2.60    | 3.05                     | 3.12 | 3.25 | 3.40 | 2.91 | 0.16               |
| P <sub>2</sub> O <sub>5</sub> | 0.47    | 0.52                     | 0.51 | 0.51 | 0.52 | 0.52 | 0.03               |
| K <sub>2</sub> O              | 4.06    | 4.13                     | 3.99 | 4.03 | 4.03 | 4.13 | 0.21               |
| CaO                           | 0.81    | 0.77                     | 0.72 | 0.74 | 0.74 | 0.71 | 0.10               |
| MgO                           | 0.44    | 0.52                     | 0.52 | 0.52 | 0.46 | 0.50 | 0.07               |

Yield Data

| Treatment   | Height<br>at Shooting<br>(ins.) | % Shot | Mean Bunch<br>Weight<br>(lbs.) |
|-------------|---------------------------------|--------|--------------------------------|
| 1           | 99                              | 70.5   | 21.8                           |
| 2           | 101                             | 76.9   | 20.1                           |
| 3           | 96                              | 78.5   | 17.5                           |
| 4           | 103                             | 81.5   | 19.8                           |
| 5           | 98                              | 84.6   | 17.4                           |
| Mean        | 99                              | 78.4   | 19.3                           |
| LSD P= 0.05 | 7.9                             | 27.9   | 6.6                            |

**Phys. 4     FRUIT INVESTIGATIONS: CROP TIMING GIBBERELLIN EXPERIMENT  
ORANGE RIVER**

Layout: 4 Randomised Blocks

Treatments:

1. Control
2. Single spraying with 100 ppm GA
3. Two sprayings, 14 days apart, with 100 ppm GA
4. Single injection of 100 ppm GA
5. Two injections, 14 days apart, of 100 ppm GA

| Treatment | % Mats<br>Shot | Duration<br>of<br>Shooting<br>(weeks) | Mean<br>Maturation<br>Period<br>(weeks) | Mean<br>No. of<br>Hands/bunch | Mean<br>Bunch<br>Weight<br>(lb.) |
|-----------|----------------|---------------------------------------|-----------------------------------------|-------------------------------|----------------------------------|
| 1         | 95             | 30                                    | 12.2                                    | 6.1                           | 24.1                             |
| 2         | 97             | 33                                    | 12.5                                    | 6.9                           | 26.0                             |
| 3         | 97             | 33                                    | 12.7                                    | 6.3                           | 23.3                             |
| 4         | 86             | 36                                    | 12.8                                    | 6.5                           | 22.7                             |
| 5         | 81             | 43                                    | 10.1                                    | 5.8                           | 17.3                             |

## Anal. 1

LEAF ANALYSIS RESULTS OF 3 x 3 x 3 NPK FACTORIAL EXPERIMENT SHOWING  
NUTRIENT RESPONSES IN THE PLANT TO FERTILIZER APPLICATION

3 Blocks of 9 plots

Treatments:

(N) Sulphate of Ammonia

(P) Single Superphosphate

(K) Muriate of Potash

all at

0, ¼ lb., ½ lb.

per mat 4 times/year

| % Content                     | N <sub>0</sub> | N <sub>1</sub> | N <sub>2</sub> | P <sub>0</sub> | P <sub>1</sub> | P <sub>2</sub> | K <sub>0</sub> | K <sub>1</sub> | K <sub>2</sub> | C.V. | LSD<br>P = 0.05 |
|-------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|------|-----------------|
| N                             | 2.86           | 3.06           | 3.46           | 3.25           | 3.11           | 3.01           | 3.18           | 3.12           | 3.07           | 8.2  | 0.29            |
| P <sub>2</sub> O <sub>5</sub> | 0.45           | 0.43           | 0.44           | 0.41           | 0.45           | 0.46           | 0.45           | 0.44           | 0.43           | 7.5  | 0.04            |
| K <sub>2</sub> O              | 4.18           | 3.94           | 3.83           | 3.98           | 3.92           | 4.04           | 3.82           | 3.96           | 4.16           | 5.7  | 0.26            |
| CaO                           | 0.50           | 0.45           | 0.58           | 0.58           | 0.49           | 0.46           | 0.46           | 0.48           | 0.45           | 28.4 |                 |
| MgO                           | 0.45           | 0.42           | 0.39           | 0.44           | 0.43           | 0.39           | 0.41           | 0.42           | 0.44           | 6.3  | 0.03            |

|           | <u>Block I</u> | <u>Block II</u> | <u>Block III</u> | <u>L.S.D. P = 0.05</u> |
|-----------|----------------|-----------------|------------------|------------------------|
| Magnesium | 0.42           | 0.46            | 0.39             | 0.03                   |

## Anal. 2

DISTRIBUTION OF COLLECTION SITES FOR  
BANANA SOIL FERTILITY SURVEY

| <u>PARISHES</u> | <u>SITES</u> |
|-----------------|--------------|
| Kingston        | nil          |
| St. Andrew      | nil          |
| St. Thomas      | 3            |
| Portland        | 5            |
| St. Mary        | 7            |
| St. Ann         | 1            |
| Trelawny        | 1            |
| St. Elizabeth   | 1            |
| Clarendon       | 1            |
| St. Catherine   | 3            |
| Westmoreland    | nil          |
| Hanover         | 2            |
| St. James       | 8            |

MAJOR NUTRIENT CONTENT OF LACATAN BANANA PLANTS (AVERAGE OF 2)

| Part of Plant         | Dry matter % | Dry matter gm | Nitrogen (N) |                 | Phosphate ( $P_2O_5$ ) |                 | Potash ( $K_2O$ ) |                 | Calcium (CaO) |                 | Magnesium (MgO) |                 |
|-----------------------|--------------|---------------|--------------|-----------------|------------------------|-----------------|-------------------|-----------------|---------------|-----------------|-----------------|-----------------|
|                       |              |               | % of D.M.    | Total Weight gm | % of D.M.              | Total Weight gm | % of D.M.         | Total Weight gm | % of D.M.     | Total Weight gm | % of D.M.       | Total Weight gm |
| Roots                 | 6.97         | 35.35         | 1.00         | 0.35            | 0.15                   | 0.05            | 5.97              | 2.12            | 1.03          | 0.36            | 0.57            | 0.20            |
| Rhizome or 'Corm'     | 13.09        | 938.40        | 0.97         | 9.38            | 0.21                   | 1.97            | 4.83              | 46.92           | 1.35          | 12.67           | 0.52            | 4.88            |
| Pseudostem            | 6.35         | 1972.70       | 1.10         | 19.73           | 0.26                   | 5.13            | 9.19              | 177.54          | 1.21          | 23.87           | 0.53            | 10.46           |
| Fruit Stalk           | 19.18        | 306.50        | 2.07         | 6.13            | 0.65                   | 1.99            | 9.26              | 27.59           | 0.84          | 2.57            | 0.45            | 1.38            |
| Fruit                 | 13.58        | 718.00        | 1.99         | 14.36           | 0.50                   | 3.59            | 6.33              | 43.08           | 0.93          | 6.68            | 0.56            | 4.02            |
| Short Leaf            | 13.90        | 35.05         | 2.50         | 1.05            | 0.50                   | 0.18            | 5.18              | 1.75            | 0.90          | 0.32            | 0.46            | 0.16            |
| Bract                 | 19.82        | 7.85          | 1.49         | 0.08            | 0.32                   | 0.03            | 5.33              | 0.39            | 1.42          | 0.11            | 0.72            | 0.06            |
| Inflorescence         | 8.74         | 49.55         | 2.99         | 1.49            | 0.79                   | 0.39            | 8.80              | 4.46            | 0.78          | 0.39            | 0.62            | 0.31            |
| Dry Leaves            | 30.03        | 130.95        | 1.11         | 1.31            | 0.15                   | 0.20            | 3.21              | 3.93            | 1.30          | 1.70            | 0.47            | 0.62            |
| Petioles              | 12.15        | 261.70        | 0.81         | 2.62            | 0.18                   | 0.47            | 7.72              | 20.94           | 1.55          | 4.06            | 0.38            | 0.99            |
| Lamina                | 15.57        | 1504.05       | 2.87         | 45.12           | 0.40                   | 6.02            | 4.12              | 60.16           | 0.87          | 13.09           | 0.41            | 6.17            |
| Midribs               | 18.29        | 2214.70       | 0.82         | 18.29           | 0.23                   | 5.09            | 4.83              | 110.74          | 0.96          | 21.26           | 0.30            | 6.87            |
| Total weight in plant | —            | 8174.80       | —            | 119.91          | —                      | 25.11           | —                 | 499.62          | —             | 87.08           | —               | 36.12           |



## MICRONUTRIENT TRIAL — ST. MARY

Layout: 4 randomised blocks. Plot size 4 mats.

Treatments: (soil and foliar applications carried out twice per year).

1. Control
2. Magnesium — ¼ lb./root of Kieserite as a soil application
3. Manganese — ¼ lb./root of Manganese-chelate as a soil application
4. Iron — ¼ lb./root of Fe-chelate as a soil application
5. Zinc — ¼ lb./root of Zn-chelate as a soil application
6. Esminel — 5% Esminel solution as a foliar spray application
7. Boron — 5% Borax solution as a foliar spray application
8. Molybdenum — 0.3% Sodium Molybdate as a foliar spray application

## Analysis Data for 2nd Ratoon Crop

| Treatments | Mean days to shooting* | Mean height at shooting | Mean girth of pseudostem at shooting | Mean no. of hands per stem |
|------------|------------------------|-------------------------|--------------------------------------|----------------------------|
| 1          | 219.5                  | 124.7                   | 7.0                                  | 8.0                        |
| 2          | 226.0                  | 115.4                   | 6.5                                  | 6.7                        |
| 3          | 250.2                  | 135.6                   | 7.1                                  | 8.1                        |
| 4          | 282.4                  | 128.7                   | 6.8                                  | 7.3                        |
| 5          | 224.4                  | 116.0                   | 6.1                                  | 6.0                        |
| 6          | 229.2                  | 120.5                   | 6.9                                  | 7.5                        |
| 7          | 262.4                  | 115.0                   | 6.3                                  | 6.7                        |
| 8          | 221.0                  | 118.0                   | 6.8                                  | 7.0                        |

Sig. Diff. P,0.05      110.8      15.2      0.8      1.7

P,0.01      150.6      20.6      1.0      2.3

C.V.      31.3      8.4      7.6      15.7

\*Calculated from — 1-1-60.

CaPK - 3<sup>3</sup> FACTORIAL EXPERIMENT - ST. MARY

Layout: 3 Blocks of 9 plots each

Treatments:

Ca - A single application of lime at nil, one half and full lime requirement, as determined by the method of Woodruff (1948)

|                           |   |
|---------------------------|---|
| P - Single Superphosphate | } |
| K - Muriate of Potash     |   |

all at 0, ¼ lb. and ½ lb. per plant three times each year.

Plus a basic application of Sulphate of Ammonia at the rate of 3 ozs. per root to all plants every 2 months.

|                                       | Ca <sub>0</sub> | Ca <sub>1</sub> | Ca <sub>2</sub> | P <sub>0</sub> | P <sub>1</sub> | P <sub>2</sub> | K <sub>0</sub> | K <sub>1</sub> | K <sub>2</sub> | Sig. Diff.<br>P. .05 | Sig. Diff.<br>P. .01 | Coeff. Var.<br>(% G.M.) |
|---------------------------------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------------|----------------------|-------------------------|
| Mean days to shooting*                | 125.1           | 143.2           | 125.6           | 118.3          | 147.2          | 128.3          | 137.5          | 129.2          | 127.1          | 48.5                 | 73.4                 | 31.9                    |
| Mean height at shooting               | 96.1            | 95.9            | 91.3            | 96.0           | 94.1           | 93.1           | 92.8           | 95.2           | 95.2           | 7.8                  | 11.9                 | 7.2                     |
| Mean girth of pseudo-stem at shooting | 6.31            | 6.09            | 6.09            | 6.28           | 6.14           | 6.07           | 6.20           | 6.13           | 6.16           | 0.23                 | 0.35                 | 3.24                    |
| Mean no. of hands per stem            | 6.56            | 6.28            | 6.02            | 6.29           | 6.17           | 6.18           | 6.14           | 6.20           | 6.29           | 0.42                 | 0.63                 | 5.8                     |

\*Calculated from 1.1.61.

pH CHANGES IN SOIL  
(mean values of experimental plots).

| Time of Sampling      | Depth | Ca <sub>0</sub> | Ca <sub>1</sub> | Ca <sub>2</sub> |
|-----------------------|-------|-----------------|-----------------|-----------------|
| Before liming         | 0-9   | 4.5             | 4.5             | 4.5             |
|                       | 9-18  | 4.5             | 4.6             | 4.6             |
| 6 months after liming | 0-9   | 4.7             | 5.1             | 5.9             |
|                       | 9-18  | 4.8             | 4.8             | 5.4             |

## Chem. 3

## FORKING EXPERIMENT

Layout: 5 randomized blocks of 4 treatments

Main Treatments:

1. Control — no forking
2. Forking of a ring about 2 ft. in radius around each plant
3. Forking the whole area except for a ring about 2 ft. in radius around each plant
4. Forking the whole area

Sub-treatments:

- A. Forked once per year
- B. Forked once in two years

## INTERIM RESULTS (PLANT CROP)

\*Calculated from — 1-4-60.

| Treatments        | Mean days to shooting* | Mean height at shooting | Mean girth of pseudostem at shooting | Mean no. of hands per stem |
|-------------------|------------------------|-------------------------|--------------------------------------|----------------------------|
| 1                 | 129.37                 | 104.07                  | 6.30                                 | 6.84                       |
| 2                 | 100.18                 | 99.28                   | 6.25                                 | 6.81                       |
| 3                 | 116.65                 | 100.00                  | 6.21                                 | 6.61                       |
| 4                 | 79.27                  | 99.57                   | 6.49                                 | 6.73                       |
| Sig. Diff. P,0.05 | 68.57                  | 6.53                    | 0.38                                 | 0.58                       |
| P,0.01            | 96.13                  | 9.15                    | 0.53                                 | 0.82                       |
| C.V.              | 46.79                  | 4.70                    | 4.35                                 | 6.29                       |
| A                 | 112.05                 | 98.58                   | 6.18                                 | 6.58                       |
| B                 | 100.69                 | 102.88                  | 6.44                                 | 6.92                       |
| Sig. Diff. P,0.05 | 18.15                  | 2.25                    | 0.12                                 | 0.22                       |
| P,0.01            | 25.00                  | 3.10                    | 0.17                                 | 0.30                       |
| C.V.              | 36.00                  | 4.71                    | 4.02                                 | 6.74                       |



## MANGANESE DEFICIENCY SPRAYING TRIAL

Progress report on fruit condition of experimental plants at Hopewell, St. Mary, receiving various foliar treatments and one soil treatment. (of. Appendix Chem. 3 in 1960 Annual Report).

| Treatment Received             | Fruit condition of Plant A | Fruit condition of plant B | Fruit condition of follower of plant A | Fruit condition of follower of plant B |
|--------------------------------|----------------------------|----------------------------|----------------------------------------|----------------------------------------|
| (1) 2% Magnesium Sulphate      | Medium                     | severe                     | severe                                 | medium<br>very slight                  |
| (2) 1% Manganese Sulphate      |                            |                            |                                        |                                        |
| (3) 1% Ferrous Sulphate        |                            |                            |                                        |                                        |
| (4) 1% Borax                   |                            |                            |                                        |                                        |
| (5) 1% Ammonium Molybdate      |                            |                            |                                        |                                        |
| (6) 1% Zinc Sulphate           |                            |                            |                                        |                                        |
| (7) Sulphur (soil application) |                            |                            |                                        |                                        |
| (8) Control                    |                            |                            |                                        |                                        |
| (9) 1% Ammonium Molybdate      |                            |                            |                                        |                                        |
| (10) 1% Ammonium Sulphate      |                            |                            |                                        |                                        |

## Chem. 5

**MANGANESE DEFICIENCY SOIL AMENDMENT TRIAL**  
(Hopewell, St. Mary)

Progress report on fruit of plants  
each receiving certain chemicals.

| Treatment Received                                       | Fruit condition<br>of Plant A | Fruit condition<br>of Plant B |
|----------------------------------------------------------|-------------------------------|-------------------------------|
| 1. Manganese chelate — ¼ lb. per root<br>twice each year | medium                        | medium                        |
| 2. Kieserite — ½ lb. per root twice each<br>year         | medium                        | medium                        |
| 3. Iron Chelate — ¼ lb. per root twice<br>each year      | dead                          | medium                        |
| 4. Muriate of Potash — ¼ lb. per root<br>twice each year | medium                        | medium                        |
| 5. Control                                               |                               | medium                        |

## Chem. 6

**MANGANESE AND SPECKLE FRUIT SPRAYING  
EXPERIMENT, ST. CATHERINE PLAINS.**

| Treatment                                | Mean speckle assessment<br>7 weeks from initiation<br>of experiment | Mean speckle assessment<br>10 days after inoculation<br>with <i>D. torulosa</i> | Mean Manganese<br>level in ppm (odm)<br>of fruit |
|------------------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------|
| 1% Manganese sulphate<br>twice each week | 1.63                                                                | 2.63                                                                            | 96.7                                             |
| Water twice each week                    | 1.57                                                                | 2.67                                                                            | 10                                               |
| t                                        | 0.35                                                                | 0.26                                                                            | 11.93                                            |
| t (.05 level)                            | 2.05                                                                | 2.05                                                                            | 2.05                                             |
| (.01 level)                              | 2.76                                                                | 2.76                                                                            | 2.77                                             |
| (.001 level)                             | 3.67                                                                | 3.67                                                                            | 3.69                                             |

## Chem. 7

**ZINC DEFICIENT PLANT COMPARISONS**

Mean length-breadth ratios and leaf analysis figures for  
16 affected and 16 unaffected plants,  
St. Catherine plains.

|                   | Length Breadth<br>Ratio | % P <sub>2</sub> O <sub>5</sub> | % K <sub>2</sub> O | % CaO | % MgO |
|-------------------|-------------------------|---------------------------------|--------------------|-------|-------|
| Affected Plants   | 3.8                     | 0.50                            | 4.34               | 1.32  | 0.65  |
| Unaffected Plants | 3.2                     | 0.43                            | 4.02               | 0.96  | 0.64  |
| t                 | 4.61                    | 3.61                            | 3.11               | 4.27  | 0.30  |

t (0.05 level) = 2.04

(0.01 level) = 2.75

(0.001 level) = 3.65

## Agr. 1.

| Treatment                      | Total no.<br>shot/plot | Av. no.<br>Hands/stem | Total count<br>bunches/plot | Av. no of weeks to<br>shooting |            |
|--------------------------------|------------------------|-----------------------|-----------------------------|--------------------------------|------------|
|                                |                        |                       |                             | Plants                         | 1st Ratoon |
| A                              | 23.4                   | 7.4                   | 14.00                       | 61.7                           | 111.4      |
| B                              | 23.2                   | 7.2                   | 12.30                       | 61.2                           | 113.9      |
| C                              | 22.2                   | 7.3                   | 12.60                       | 60.9                           | 113.4      |
| D                              | 20.8                   | 7.1                   | 10.95                       | 62.7                           | 115.0      |
| E                              | 22.2                   | 7.1                   | 11.70                       | 63.7                           | 117.0      |
| Least sig. diff.<br>at P = .05 |                        | 7.4                   | .8                          | 6.7                            | 5.6        |
|                                |                        |                       |                             |                                | 14.4       |

## Agr. 2.

|                                         | Standard Estate<br>Pruning | 12-month | 15-month |
|-----------------------------------------|----------------------------|----------|----------|
| Av. no. stems/plot<br>Summer Production | 30                         | 34       | 30       |
| Av. no. stems/plot<br>Winter Production | 23                         | 21       | 26       |
| Av. no. hands/stem<br>per plot          | 6.2                        | 6.3      | 6.2      |
| Total Production                        |                            |          |          |

## Agr. 3

|                         | % Shooting in<br>12-month<br>Pruning Area | % Shooting in Standard<br>Estate<br>Pruning Area |
|-------------------------|-------------------------------------------|--------------------------------------------------|
| Total Production        | 2560                                      | 2271                                             |
| October - December 1958 | 22.2                                      | 30.7                                             |
| January - March 1959    | 25.7                                      | 34.0                                             |
| April - June 1959       | 20.5                                      | 30.0                                             |
| July - September 1959   | 19.0                                      | 28.4                                             |
| October - December 1959 | 19.7                                      | 25.0                                             |
| January - March 1960    | 27.6                                      | 24.0                                             |
| April - June 1960       | 18.0                                      | 18.4                                             |
| July - September 1960   | 22.4                                      | 26.4                                             |
| October - December 1960 | 19.7                                      | 18.5                                             |
| January - March 1961    | 18.5                                      | 19.3                                             |
| April - June 1961       | 12.7                                      | 15.0                                             |
| July - September 1961   | 22.5                                      | 26.6                                             |
| October - December 1961 | 23.6                                      | 26.0                                             |



## P.B. 1

## POLLINATION AND SEED YIELD

| Cross       | Stems Pol-<br>inated | Stems<br>Reaped | Stems<br>Fertile | Seeds<br>Obtained |
|-------------|----------------------|-----------------|------------------|-------------------|
| Gros Michel | 3379                 | 2765            | 508              | 1010              |
| Highgate    | 1417                 | 1144            | 162              | 250               |
| 1847        | 57                   | 32              | —                | 1419              |
| 2390        | 90                   | 47              | —                | 1042              |
| 10648       | 8                    | —               | —                | —                 |
| 12046       | 2                    | —               | —                | —                 |

## P.B. 2

## SEED PLANTED, GERMINATIONS AND SEEDLINGS

| Cross       | Seed<br>Sown | Germin-<br>ations | Deaths | Tld's | Potted |
|-------------|--------------|-------------------|--------|-------|--------|
| Gros Michel | 982          | 263               | 24     | 181   | 75     |
| Highgate    | 242          | 75                | 1      | 19    | 55     |
| 1847        | 1254         | 34                | —      | —     | 54     |
| 2390        | 398          | 46                | —      | —     | 46     |

## P.B. 3

## SEEDLINGS IN THE NURSERY AND SELECTION

| Cross       | On<br>Hand | Planted<br>Out | Selected | Dis-<br>carded | Remain-<br>ing |
|-------------|------------|----------------|----------|----------------|----------------|
| Gros Michel | 155        | 124            | 9        | 109            | 161            |
| Highgate    | 14         | 57             | 2        | 8              | 61             |
| 1847        | —          | 40             | —        | —              | 40             |
| 2390        | —          | 31             | —        | —              | 31             |

## P.B. 4

## PANAMA DISEASE TESTING

| Cross       | On<br>Hand | Planted<br>Out | Selected | Dis-<br>carded | Remain-<br>ing |
|-------------|------------|----------------|----------|----------------|----------------|
| Gros Michel | 11         | 9              | —        | 6              | 14             |
| Highgate    | 7          | 2              | —        | 6              | 3              |

## Cyto. 1

## YIELDS FROM GROUPED FEMALE PARENTS IN A SERIES

| Female       | Pollinated | Reaped | Total seeds | Best Bunch | Seeds sown | Germinated |
|--------------|------------|--------|-------------|------------|------------|------------|
| Tongat       | 375        | 287    | 3833        | 111        | 3596       | 562        |
| Paka         | 97         | 67     | 496         | 86         | 783        | 8          |
| 4053         | 162        | 118    | 2460        | 110        | 1966       | 27         |
| Samoa hybrid | 79         | 83     | 41000       | 3954       | 12651      | 1551       |
| Others       | 323        | 189    | 11120       | 1553       | 4670       | 170        |

## Cyto. 2

## SEEDS FROM FINGERS TREATED WITH GROWTH-ACTIVE SUBSTANCES

| Female                    | Bunches | Hands | Fertile | Seeds from treatment |        |       |
|---------------------------|---------|-------|---------|----------------------|--------|-------|
|                           |         |       |         | Time 1               | Time 2 | Water |
| Thiourea trials           |         |       |         |                      |        |       |
| Awak Legor                | 1       | 11    | 11      | 813                  | 810    | 825   |
| Bluggoe                   | 6       | 29    | 24      | 91                   | 99     | 68    |
| Ney Mannan                | 2       | 17    | 11      | 470                  | 379    | 464   |
| Red                       | 3       | 33    | 15      | 46                   | 50     | 97    |
| Paka                      | 1       | 6     | 5       | 9                    |        | 2     |
| Tongat                    | 8       | 106   | 38      | 54                   |        | 52    |
| 4053                      | 5       | 33    | 15      | 24                   |        | 45    |
| Indolebutyric acid trials |         |       |         |                      |        |       |
| Bluggoe                   | 5       | 21    | 18      | 51                   | 64     | 65    |
| Red                       | 1       | 3     | 3       | 14                   | 8      | 36    |
| Gibberellic acid trials   |         |       |         |                      |        |       |
| Bluggoe                   | 1       | 5     | 4       | 18                   | 20     | 21    |
| Ney Mannan                | 3       | 22    | 22      | 857                  | 1015   | 889   |
| Red                       | 2       | 8     | 7       | 15                   | 19     | 27    |
| Paka                      | 7       | 31    | 11      | 48                   |        | 66    |
| Tongat                    | 8       | 81    | 20      | 27                   |        | 24    |
| 4053                      | 2       | 9     | 6       | 24                   |        | 37    |

## Cyto. 3.

## GERMINATIONS RELATED TO MONTH OF SOWING: 1955.

## DATA AND SUMMARY SEPTEMBER 1949 - MAY 1961

| Month     | 1949 - 61  |              |               |               | 1955 only  |              |               |
|-----------|------------|--------------|---------------|---------------|------------|--------------|---------------|
|           | Seeds Sown | % germinated | % tetra-ploid | % tetra germ. | Seeds Sown | % germinated | % tetra-ploid |
| January   | 2570       | 28.9         | 5.8           | 20.1          | 520        | 35.2         | 7.1           |
| February  | 2034       | 33.6         | 7.0           | 20.8          | 491        | 48.5         | 9.8           |
| March     | 2705       | 37.0         | 7.2           | 19.4          | 697        | 44.3         | 9.9           |
| April     | 3433       | 39.2         | 11.7          | 30.0          | 775        | 50.6         | 16.1          |
| May       | 3197       | 37.4         | 12.8          | 34.3          | 409        | 59.2         | 28.1          |
| June      | 3262       | 35.8         | 13.3          | 37.1          | 370        | 45.4         | 21.6          |
| July      | 4067       | 38.4         | 10.6          | 27.7          | 258        | 39.5         | 14.7          |
| August    | 3705       | 33.2         | 7.3           | 22.1          | 466        | 26.8         | 5.8           |
| September | 4429       | 24.8         | 5.3           | 21.4          | 1052       | 23.6         | 6.5           |
| October   | 3854       | 21.2         | 3.8           | 18.1          | 1141       | 21.5         | 4.5           |
| November  | 3034       | 21.2         | 3.6           | 16.9          | 650        | 23.8         | 4.6           |
| December  | 2810       | 24.2         | 3.7           | 15.1          | 611        | 17.7         | 2.0           |
| Total     | 39100      | 31.1         | 7.7           | 24.9          | 7440       | 33.8         | 9.4           |

| Crosses compared          | Period          | Cross 1 |     |      | Cross 2 |     |      | Cross 3 |     |      |
|---------------------------|-----------------|---------|-----|------|---------|-----|------|---------|-----|------|
|                           |                 | Sown    | %g. | % 4x | Sown    | %g. | % 4x | Sown    | %g. | % 4x |
| PL v LT v T14             | 7-8/51          | 295     | 42  | 6.1  | 205     | 48  | 10.7 | 140     | 43  | 6.4  |
| " " "                     | 3-8/52          |         |     |      | 73      | 37  | 7.0  | 370     | 31  | 3.5  |
| " " "                     | 9/52-2/53       | 114     | 18  | 1.8  | 465     | 20  | 2.4  | 896     | 21  | 2.5  |
| T14 v T16                 | 6-8/53          | 634     | 41  | 12.3 | 171     | 42  | 8.8  |         |     |      |
| " "                       | 9/53-2/54       | 1280    | 25  | 5.5  | 415     | 25  | 2.9  |         |     |      |
| " "                       | 3-4/54          | 421     | 44  | 15.0 | 247     | 38  | 6.9  |         |     |      |
| T16 v T23                 | 9/54-2/55       | 2487    | 30  | 4.7  | 442     | 32  | 6.6  |         |     |      |
| " "                       | 3-7/55          | 1999    | 49  | 16.2 | 374     | 47  | 20.6 |         |     |      |
| " " v T24                 | 9/55-2/56       | 1323    | 26  | 4.8  | 2620    | 23  | 5.5  | 355     | 24  | 4.5  |
| " "                       | 3-7/56          | 280     | 47  | 12.5 | 1151    | 45  | 12.9 |         |     |      |
| " " v T25                 | 5-7/56 only     | 150     | 56  | 14.7 | 484     | 45  | 15.7 | 591     | 47  | 12.4 |
| " "                       | 9/56-2/57       | 149     | 23  | 7.4  | 782     | 34  | 7.7  | 692     | 31  | 5.3  |
| T25 v T28                 | 3-8/57          | 908     | 42  | 11.5 | 351     | 43  | 13.7 |         |     |      |
| " "                       | 9/57-2/58       | 364     | 29  | 4.4  | 170     | 25  | 4.1  |         |     |      |
| " " v T27                 | 12/57-2/58 only | 189     | 26  | 5.8  | 76      | 24  | 2.6  | 175     | 29  | 2.9  |
| T27 v 7510L*              | 7-8/59          | 284     | 34  | 9.2  | 314     | 34  | 11.1 |         |     |      |
| " "                       | 8/59 only       | 191     | 34  | 11.0 | 263     | 33  | 11.0 |         |     |      |
| 7510L v 8046E<br>v 8058A* | 6-8/60          | 409     | 24  | 7.8  | 149     | 33  | 10.1 | 455     | 22  | 9.5  |

\* 7510L, 8046E and 8058A are the aggregated figures from male parents derived from these families.

| Treatment |          | Germinations out of 100 |            | Days to germinate |      |
|-----------|----------|-------------------------|------------|-------------------|------|
| Night     | Day      | First 80 days           | Subsequent | First             | Last |
| Box       | Sun      | 13                      | 0          | 26                | 65   |
| GH        | Sun      | 8                       | 0          | 40                | 65   |
| GH        | GH       | 3                       | 2          | 53                | 144  |
| Box       | GH       | 0                       | 5          | 90                | 162  |
| 75°       | 75°      |                         |            |                   |      |
| then GH   | then sun | 0                       | 4          | 100               | 115  |



Cyto 6.

**GERMINATIONS IN 12 WEEKS FROM LOTS OF 100 SEEDS SOAKED FOR 7 OR 14 DAYS WITH OR WITHOUT 200PPM. GIBBERELIC ACID (GA), WITH OR WITHOUT 1000 PPM. THIOUREA (TU).**

| Treatment         | A   | B   | C   | D   | E   | TOTAL |
|-------------------|-----|-----|-----|-----|-----|-------|
| 1 GA TU 7 days    | 42  | 37  | 29  | 31  | 54  | 183   |
| 2 GA — 7 days     | 7   | 24  | 29  | 24  | 35  | 129   |
| 3 — TU 7 days     | 10  | 37  | 30  | 32  | 49  | 156   |
| 4 — — 7 days      | 24  | 25  | 29  | 23  | 46  | 147   |
| 5 GA TU 14 days   | 16  | 30  | 29  | 16  | 71  | 162   |
| 6 GA — 14 days    | 18  | 29  | 25  | 42  | 48  | 162   |
| 7 — TU 14 days    | 15  | 31  | 24  | 28  | 54  | 152   |
| 8 — — 14 days     | 24  | 24  | 29  | 32  | 61  | 170   |
| 9 Control — sand  | 32  | 17  | 25  | 25  | 40  | 139   |
| 10 Control — soil | 24  | 42  | 23  | 16  | 38  | 143   |
| Total 1-10        | 212 | 296 | 271 | 269 | 506 | 1543  |
| Total 1- 8        | 156 | 237 | 223 | 228 | 428 | 1261  |
| GA                | 83  | 120 | 112 | 113 | 218 | 646   |
| —                 | 73  | 117 | 112 | 115 | 210 | 625   |
| TU                | 83  | 135 | 112 | 107 | 228 | 663   |
| —                 | 73  | 102 | 112 | 121 | 200 | 608 ! |
| 7                 | 83  | 123 | 117 | 110 | 194 | 625   |
| 14                | 73  | 114 | 107 | 118 | 234 | 646   |
| GA 7              | 49  | 61  | 58  | 55  | 99  | 322   |
| — 7               | 34  | 62  | 59  | 55  | 95  | 303   |
| GA 14             | 34  | 59  | 54  | 58  | 119 | 324   |
| — 14              | 39  | 55  | 53  | 60  | 115 | 322   |
| TU 7              | 52  | 74  | 59  | 63  | 103 | 349   |
| — 7               | 31  | 49  | 58  | 47  | 91  | 276 ! |
| TU 14             | 31  | 61  | 53  | 44  | 125 | 314   |
| — 14              | 42  | 53  | 54  | 74  | 109 | 332   |
| GA TU             | 58  | 67  | 58  | 47  | 125 | 355   |
| GA —              | 25  | 53  | 54  | 66  | 93  | 291   |
| — TU              | 25  | 68  | 54  | 60  | 103 | 308   |
| — —               | 48  | 49  | 58  | 55  | 107 | 317   |

Cyto. 7

**EMBRYO SAC PRODUCTION AND POLLEN TUBE PENETRATION**

|            | At receptivity |      |        | Post-receptivity |      |        |              |
|------------|----------------|------|--------|------------------|------|--------|--------------|
|            | Ovules         | Sacs | Normal | Ovules           | Sacs | Normal | Pollen tubes |
| Diploid    |                |      |        |                  |      |        |              |
| Paka       | 128            | 75   | 21     | 325              | 160  | 27     | 2 + 3        |
| Sikuzani   | 138            | 127  | 50     | 278              | 250  | 107    | 0            |
| Tongat     | 102            | 20   | 5      | 452              | 100  | 42     | 5 + 4        |
| Triploid   |                |      |        |                  |      |        |              |
| Bluggoe    | 203            | 77   | 22     | 176              | 62   | 3      | 0            |
| Ney Mannan | 221            | 101  | 34     | 211              | 108  | 27     | 3 + 0        |

# STAFF AT 31ST DECEMBER, 1961

|                               |                                                                                       |
|-------------------------------|---------------------------------------------------------------------------------------|
| Director .. .. .              | Vacant (E. A. Tai acting)                                                             |
| Crop Physiologist .. ..       | E. A. Tai, M.Sc., D.I.C.T.A.                                                          |
| Plant Pathologist .. ..       | D. S. Meredith, M.A., Ph.D., M.I. Biol.                                               |
| Agronomist .. .. .            | V. R. Lumsden, B.A., Dip. Agr. (Cantab.)                                              |
| Soil Chemist .. .. .          | C. G. Jordine, B.Sc., A.R.I.C.                                                        |
| Chief Analyst .. .. .         | D. E. Boland, B.Sc.                                                                   |
| Executive Field Officer .. .. | W. G. Chambers                                                                        |
| Field Officers .. .. .        | H. H. Christie, G. L. McKenzie, J. A. Morris, S. E. Crooks, W. J. Small, A. D. Watson |
| Technical Assistants .. ..    | J. A. Lai, K. C. Gray, F. G. Campbell, R. Allen, T. Wilson, Y. Gordon, J. Creary      |
| Secretary/Stenographer .. ..  | B. McLean                                                                             |
| Typists .. .. .               | V. Green, L. Bacquie, E. Latibeaudiere                                                |
| Computers .. .. .             | J. Thomas, G. Perkins                                                                 |

## Banana Breeding Research Scheme

|                              |                                                |
|------------------------------|------------------------------------------------|
| Plant Breeder .. .. .        | R. E. Osborne, D.I.C.T.A., Dip. Agr. (Reading) |
| Cytogeneticist .. .. .       | K. Shepherd, B.Sc.                             |
| Senior Station Officer .. .. | R. A. Gonsalves, B.Sc.                         |
| Technical Assistants .. ..   | H. J. Anderson, K. A. Brown                    |
| Clerical Assistant .. .. .   | A. J. Hilton                                   |
| Typist .. .. .               | Y. Z. Henry                                    |





